ALL YOU WANT TO KNOW ABOUT

EPILEPSY

M.C. MAHESHWARI

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Popular Science

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M. C. MAHESHWARI

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PREFACE

Knowledge about epilepsy has grown enormously in recent years. The prevalence rate of epilepsy in India is 5 to 10 per thousand, i.e., about 35 to 70 lacs people suffer from epilepsies. The majority of them are treated by general practitioners. There are two ways of dispersing this knowledge so that every person afflicted with epilepsy benefits from recent developments in science for the diagnosis and treatment of the disease. One is to educate general practitioners. Most of the practitioners are so busy that they do not have any time to keep themselves abreast of developments in medical sciences. In the absence of obligatory refresher courses most of the practitioners can not be motivated. The second way is to educate the patients and the relatives. You will rarely find more motivated persons than the patients with epilepsy themselves or their relatives. By giving the best scientifically based informations to this group we may stimulate greater interest among doctors. The principal objective of writing this book is to help in reaching correct diagnosis, followed by optimal therapy; and identification of non-epileptics.

This book is primarily written for people with epilepsy and their relatives. Trainees in neurology and allied subjects may find some guidelines in dealing with people suffering from epilepsy. However this does not preclude the study of standard text books on the disease. Some repetitions of facts is deliberate in order to make a particular point understandable without referring to other chapters.

Encouragement to undertake writing this book has come mainly from patients and relatives attending the out patient service of the Neurology Department of the All India Institute of Medical Sciences. Answers to common questions and problems that arise daily on any out patients day in large hospital are attempted through this book, not in the form of Dos and DONT, but by attempting to explain the facts scientifically. The author believes that this method should have a long lasting effect and should be helpful in giving up false beliefs and old established misconceptions about epilepsy. The language has been simplified at a few places at the cost of scientific accuracy to make the facts understandable.

I an extremely grateful to my wife Dr. Shashi Maheshwari who not only provided the right milieu but also continuous encouragement to complete this task.

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M. C. Maheshwari

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DEFINITION

THE BRAIN CELLS (neurons) like many other cells in the body have the built-in capacity to generate potentials or electric signals. It is through these signals that the message is transmitted to a far off part of the body. A brain cell may be receiving several messages while sending out different messages at the same time. It is normally done in a very meticulous orderly fashion. Therefore, different functional signals or messages are not jumbled up. The brain acts like a telephone switch board. If the incoming and outgoing calls are plugged in wrongly or there is something else wrong with the switch board then there is chaos and impairment of communications. All functional activities are represented in the brain not at the same place but in different areas and at different depths. Depending upon which brain cells are impaired will reflect in the disturbed or altered functions of that area of the brain. Malfunction of the switch board can happen only once or frequently at different intervals and for different durations. Epilepsy is an electric disturbance resulting from a disorderly discharge of brain cells. The discharge is sudden and recurrent in nature. The discharge may or may not be accompanied by alteration in consciousness, or motor, sensory, psychological and behavioral functions. The clinical manifestations would depend on the nature of brain cells involved and the speed and directions of the discharge. In epilepsy as a disease, the discharge has to be recurrent. Single convulsion should not be taken as equivalent to epilepsy. Motor manifestations of a seizure are called convulsions. A single episode is called a seizure. The other common names for seizures are black outs, attacks, and fits. Thus epilepsy is a disease of the brain.

SUPERSTITIONS

FOR MANY MANY YEARS epilepsy was not considered as a brain disease. Hippocrates has suggested that the seat of the diseases is in the brain which overflows with phlegm that clogs the veins and causes convulsions. False beliefs and superstitions regarding epilepsy have existed in all societies. Through education many countries have practically eliminated these superstitions and misconceptions about epilepsy. In India superstitions and false beliefs are still wide spread and are equally prevalent both in rural and urban areas among a very high percentage of people. Many people consider that epileptic seizures are caused by supernatural powers while many others blame evil spirits, devils, demons or black magic and so on. Some people also regard epilepsy as a mental illness and a person suffering from epileptic fits is considered insane.

Approaches towards the management of epilepsies have varied according to the various beliefs mentioned above. Those who believe that the patient is possessed by evil spirits try all sorts of exorcism to let out the evil spirit. Similarly many religious ceremonies are performed to please gods and goddess. Injuries are inflicted to the patients in the attempt to eliminate the influence of demons and devils. Holes are drilled in the skull to eliminate the bad influences. The patients are made to smell the soles of torn shoes. Sprinkling of water on the eyes and face are practised by some on purify the air. Faith healers often give patients bracelets and black strings to be worn around the neck, upper arms and hands. Patients and their families are badly cheated by these people on some pretext or the other. It is not only the financial loss but the delay caused in initiating proper drug therapy that is most serious as it is responsible for serious neglect and delay in the control of the epilepsy subsequently.

These misconceptions and ignorance have led many people to believe that there are no drugs or other modes of therapy for people with epilepsy. Many young people with epilepsy have been prevented from marrying, or having children. Not only is there no truth in all these beliefs, but they have done great harm to the patients and delayed progress in controlling the epilepsy.

Epilepsy is a definite disease of the brain. One has to consider seriously how these superstitions and false beliefs have been allowed to perpetuate by society over the centuries. Only understanding of these processes will help to eradicate the ill founded and unwanted prejudices and superstitions. Most seizures are time bound and cease spontaneously in a few minutes. This spontaneous recovery often gives credit to all sorts of methods of exorcism and faith healing. During the clonic phase of a seizure, convulsions are very strong and laymen feel that when they attempt to control the patient, he is possessed with extra power or strength during the seizure. This leads them to believe that the patient has supernatural strength and this is attributed to the devil's force. In partial complex seizures the patients may suffer automatism and unresponsiveness and may even become violent. These behavioral changes which are episodic have been attributed to the episodic influence of evil spirits. It is vital therefore that people should be educated scientifically against these false beliefs, superstitions, ignorance and prejudices. Thus conveying the true scientific facts about the disease will help in eliminating and wiping out these superstitions. This may be one of the biggest human services that any society can think of.

GENETICS

THE CONTRIBUTIONS OF medical genetics in the understanding of aetiopathogenesis of diseases have been phenomenal in recent years. Attitudes towards preventing hereditary diseases have changed tremendously and are changing fast all over the globe. Epilepsy is no exception. Most of the young patients very rightly ask very penetrating questions in the out-patient departments about the genetical aspects of epilepsy which are very difficult to answer correctly and precisely. One cannot blame them for such questions as their future life style depends on them. For centuries, epilepsy at least of some types,have been known to be inherited. What has been the evidence of inheritance in epilepsy ? There is increased incidence of epilepsy in the affected family. There is increased incidence of EEG abnormalities in siblings or offsprings. There is specific epilepsy susceptibility in some families. However, it should also be appreciated that some persons may not show identifiable EEG abnormality while others who are not known to have epilepsy may nevertheless carry epilepsy traits. Several stimuli like stress, hormonal changes, environmental or physical factors can trigger off a seizure in such persons with epilepsy traits.

EEG abnormality both specific and non-specific has been studied from the genetic point of view. A large number of monozygotic twin pairs (90%) have identical EEG in contrast to 5% in dizygotic twins. Approximately 75% of the monozygotic patients demonstrate epileptiform activity in co-twins but less than 10% in the dizygotic co-twins. This high incidence of epileptiform activity in EEG from twin studies gives unquestionable support in favour of genetic influence. Similarly a high incidence of EEG abnormality, but in a much smaller degree is seen in the siblings, offsprings and other first degree relatives of patients with epilepsy even when they do not have clinical seizures. Overall EEG abnormalities either generalised or focal, are more frequently present than an actual seizure history in the relatives. Actual incidence of EEG abnormality in siblings, offsprings and other relatives varies from one study to another but is highest in siblings, lowest in other relatives and in between in offsprings. Incidence of EEG abnormality in the relatives of the patients with epilepsy is also dependent on the type of epilepsy. Generalised epilepsies have higher concordance than the focal epilepsies. One should draw one very important conclusion from genetic studies that the EEG abnormality of epileptiform nature in the siblings and offsprings of a patient with epilepsy should be interpreted with caution. EEG may have been done for any reason, this does not indicate the need of antiepileptic drugs in the absence of clinical seizure history. EEG abnormality by and large suggests a polygenetic inheritance except in some types like midtemporal spike, where autosomal dominant inheritance is responsible.

There is a considerable spectrum of opinion from no significance to very high significance on the question of whether heredity is an important factor in epilepsy or not. By and large seizure studies on siblings, offsprings and twins leave no doubt on the importance of inheritance in epilepsy. Offsprings of epileptic patients have a higher (10%) then expected seizure rate in the general population (1%). Offsprings of the epileptic mothers have a higher seizure rate than the offsprings of the epileptic fathers. Offsprings of both epileptic fathers and mothers is slightly higher than the offsprings of epileptic mothers. There is slight but definite increase in seizure rate in the siblings of epileptic patients (5%) as compared to normal populations (1%). Thus seizure rate of the siblings is lower than the seizure rate of the offsprings of epileptic patients. The older children in a family have a higher risk than the younger ones. The seizure rate is considerably higher in the monozygotic co-twins (60%) than the dizygotic co-twins (10%). Twin studies suggest a strong genetic influence on the occurrence of generalised and idiopathic seizure and a lesser influence on focal and symptomatic seizures. Overall upto 20% of the epileptic patients have a positive family history of seizure and approximately 5% in their close relatives. In some epilepsies like juvenile myoclonic epilepsy family history of epilepsy is even higher. If a parent is affected with tonic-clonic epilepsy the risk for a child is about 1 in 25 (4%). If a parent and a sibling have epilepsy the risk is increased to 1 in 10 (10%). If both parents are affected with epilepsy the risk for a child is about 1 in 8 (12%). Another important conclusion, one should draw from the genetic studies is that inspite of increased risk of seizures in the offsprings there should not be any deterrance for epileptic parents to having children. There is no way one can predict at present which child in the family is going to be affected. It is also possible that both parents with epilepsy may have a few normal children first. Thus, it perhaps is justifiable to advise patients with epilepsy to have children if they wish in the modern age where there are likely to be just one or two children per family.

The incidence of epilepsy in children is higher (2%) than in adults in general. One of 33 children are likely to have a febrile seizure (3%).The risk after one affected child is about 20 percent; if both parents and a previous child had febrile convulsions, the risk for another sibling for febrile convulsion increases to 33 percent. Siblings of children with febrile convulsions have a significantly higher rate of febrile convulsions but a non-significant rate of non-febrile convulsions may subsequently develop a non-significant rate of non febrile seizures. Ten percent of the children with febrile convulsions may subsequently develod epilepsy in life. Thus there is a definite genetic contribution in febrile seizures. Photosensitive epilepsy has similarly definite genetic influence.

Inheritance patterns in epilepsy are mostly believed to be polygenetic though autosomal dominan t and autosomal recessive have also been described. How the epilepsy trait is transmitted is not yet known. As described in the chapter on mechanism the heightened cortical excitability, the necessary requisite for the development of seizure discharge focal or generalised, may result from anatomical, physiological or biochemical changes. These changes may be under quantitative genetic control in the susceptible population. The use of histocompatibility antigens (HLA) may be helpful for identifying individuals with a high risk for epilepsy. HLA-A9 has been found significantly higher in epilepsy group and low in control group. The persons having antigen A9 are 16 times more susceptible to epilepsy than lacking it. Technology of genetic linkage is now available to identify the gene or genes responsible for seizure susceptibility. Once a gene is identified, recombinant DNA technology may be utilised in altering genetic constitution in controlling seizures in future. It is at times very difficult for the doctor to answer all questions related to inheritance of epilepsy. My advice would be to give as much information as possible after knowing the type of epilepsy and EEG abnormality.

MECHANISM

EPILEPSY IS ONE of the commonest disorder of the central nervous system (brain). Its prevalence rate in the community is 5 to 10 per thousand of the population. It is even much higher in the children being 20 to 30 per thousand. Epilepsy has been with us for centuries. How it is caused is not well understood ? However, in recent years, our understanding about the mechanism has increased and continuous efforts are being made to understand more and more.

Epilepsy may be either of focal onset or generalised from the beginning. To make the machanism of focal epilepsy simple and understandable we have to presume the existence of two types of brain cells. One group of cells is called *excitatory neurons* and the other group of cells is called *inhibitory neurons*. There are no apparent recognisable morphological differences between these two types of brain cells. Under normal circumstances the balance is maintained between these two types of cells. Electrical potentials are generated within these cells. These potentials of a group of brain cells, which are of similar nature (excitatory cells), are added and result in a burst activity. Initiation of the burst activity of these cells may be altered by injury, disease process, chemicals, genetics and others. This burst grows in size by recruiting more and more cells of the same nature from the adjoining area of the brain. When the burst reaches a critical level it results in a discharge and is expressed as a seizure. If the burst does not grow because it cannot recruit adjoining excitatory cells then the burst remains localised and cannot express as a seizure. This localised burst of electrical activity has though not resulted in the seizure can be identified as a spike activity in the electroencephalogram (EEG). For a localised burst activity terminating into a discharge requires an extreme degree of synchronization of large groups of neurons with accompanying changes in EEG.

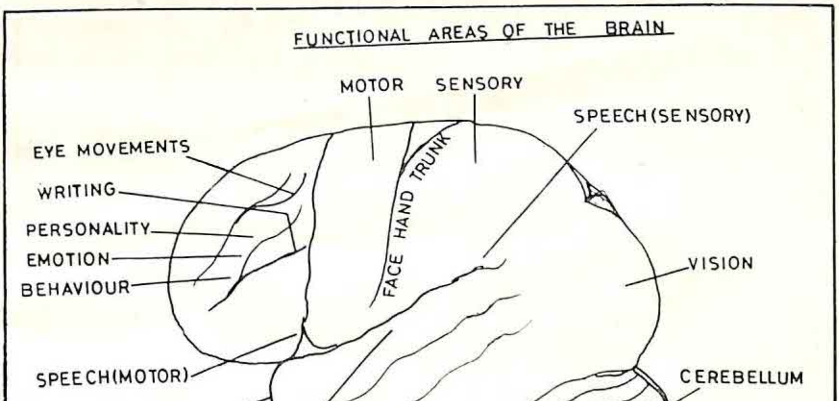

Fig. 1. Showing the locations of some important functions in the brain

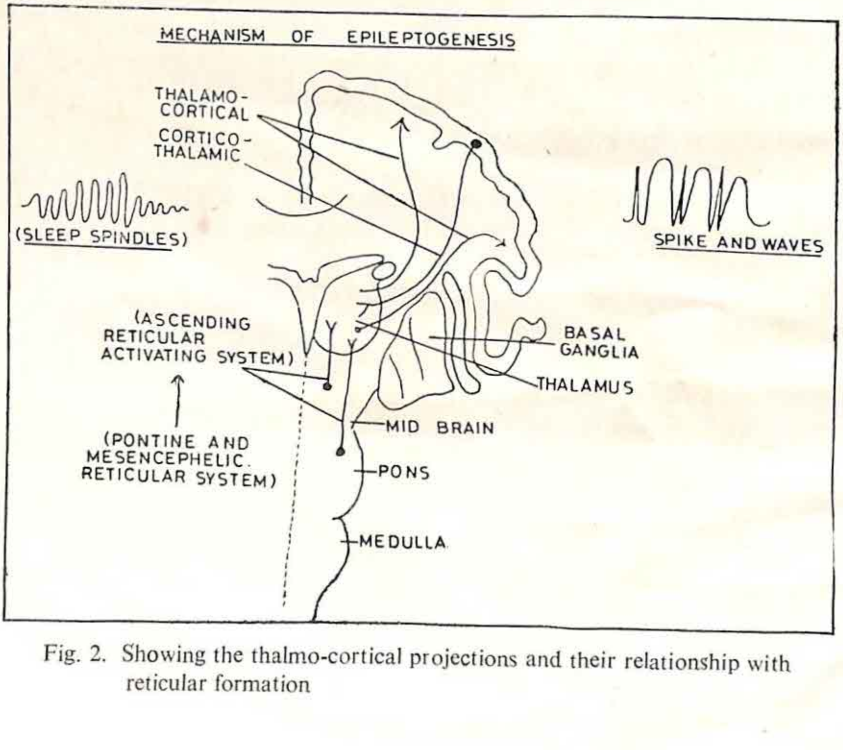
MECHANISM OF EPILEPTOGENESIS
THALAMO-CORTICAL
CORTICO-THALAMIC
(SLEEP SPINDLES)
SPIKE AND WAVES
(ASCENDING RETICULAR ACTIVATING SYSTEM)
(PONTINE AND MESENCEPHELIC. RETICULAR SYSTEM)
BASAL GANGLIA
THALAMUS
MID BRAIN
PONS
MEDULLA

Fig. 2. Showing the thalmo-cortical projections and their relationship with reticular formation

EEG changes are characterized by a synchronous discharge of high amplitude spikes and waves which are present during and sometime between the seizures. While the burst activity of the excitatory cells is building up, the inhibitory cells of the brain are also stimulated. This inhibitory influence plays a major role in seizure termination. Termination of seizure activity is also assumed to be due to a metabolic exhaustion of the brain cells. Under normal conditions these burst discharges of excitatory cells cannot be elicited because of concurrently activated inhibitory circuits that produce powerful inhibition on the same neurons.

The development of the degree of seizure activity depends on certain local characteristics of the brain area from which such an activity originates. There is individual variability. Calcium, potassium and sodium have important roles in burst generation. Many diseased conditions within or in adjoining areas may induce changes in the brain cells which make them epileptogenic. Some chemicals present in the brain like neuropeptides and gamma aminobutyric acid (GABA) etc have been known to alter neuronal excitability. Acquired or inherited alterations in brain cell membrane properties may lead to changes in excitability. Selective reduction of inhibitory process may have modifying effect on the seizure outcome. Many of the above changes either may lead to or facilitate seizure susceptibility or limit the spread of seizure. In experimental animals there are several methods by chemical application or electrical stimulation to produce focal epileptogenic area with accompanying EEG abnormality. This is called primary focus. In about 3 to 10 months a secondary focus develops in the similar area of the contralateral surface of the brain. Secondary focus once formed persists even when connection with the primary focus are severed. Formation of secondary focus can be aborted if the connections are severed before or shortly after inducing primary focus. Phenobarbitone prevents the development of secondary epileptogenic focus. In human beings a secondary focus or mirror focus can develop from any focal epileptogenic focus. Secondary epileptogenic foci should be differentiated from multiple primary foci as can happen in head injuries, infections and some degenerative and metabolic conditions.

From the above facts it is not difficult to understand variable clinical manifestations in focal epilepsies. Various activities like speech, movement, sensations, vision, smell, hearing, emotional and behaviours are located in different areas of the brain (Figure 1). The area from where the epileptogenic focus arises would give rise the disturbed function of that area and this can be elicited in the history. However, if the time interval between the onset of the focal burst and the generalised discharge is short the disturbed function of the area where the focal burst has originated, may not be elicited in the history. Focal burst however, may be recognised in EEG. Thus focal discharge may remain burried in the brain without being clinically expressed or may spread on the same side or may spread on both sides of the brain resulting in the unconsciousness.

The mechanism of generalised epilepsy is not as easy to understand as that of focal epilepsy. In the deepest part of the cerebral hemisphere there are masses of brain cells. The largest of these is the thalamus, which relays sensory information form the body to the brain surface (Cerebral cortex). Some forms of sensation like pain, touch, temperature can be appreciated at the level of the thalamus while other sensations require cerebral cortex for their appreciation. Thalamus in turn gets feed back from the cortex (Fig. 2). This thalamocortical system is responsible for arousal response and under normal circumstances generates sleep spindles and recuiting responses. These are produced as a result of summing up of burst activities of neurons through the thalamo-cortical volleys. Under normal circumstances spindle waves do not reach threshold level to elicit spike and wave response. The necessary conditions for the transformation of spindles into spike-wave pattern (seizure discharge) is the increase of cortical excitation or the depression of the tonically activating arousal response. The changes in the level of arousal have facilitatory effect on seizure activity. The recruiting drive exerted by the thalamo-cortical volleys on cortical neurons is much stronger during spike and wave discharge. The spike and wave discharges produced by the administration of penicillin in animal models is due to increased cortical excitability. This leads to increased cortical responsiveness to thalamic stimuli. Inhibitory periods develop immediately after each period of excitation or increased firing and which coincides with the slow wave of the spike and wave complex. The inhibitory period is the product of a recurrent activation of an inhibitory interneuronal system. The increased cortical activity also activates the normally high threshold intracortical inhibitory system. Loss of recurrent inhibition may be the critical factor for the tonic-clonic type of seizure discharge. Inactivation of ascending reticular activating system (ARAS) is necessary condition for the appearance of spike and wave discharges.

A disruption of the normal regulatory mechanism of the sensori-motor system at the thalamic and cortical levels can produce cortical excitability. This thalamic-cortical dysfunction can be due to structural, functional or on biochemical basis. These changes may be inherited and may be the cause of idiopathic generalised epilepsy. The changes in the structure, functional and biochemical may be very subtle and may be very difficult to demonstrate under routine examination. The simplified version of the mechanism of focal and generalised epilepsies does not explain or account for the hetero-genity of clinical seizures.

SEIZURE—TYPES

THERE ARE MANY different forms of epilepsy. However, the community by and large recognises one form (grandmal) readily as it is very dramatic and stereotyped. The manifestations of different forms of epilepsy are very variable and depend primarily on two essential features: (i) the nature of the underlying aetiological process and (ii) the part of the brain where the seizure originates and how it spreads. Epilepsies from the aetiological point of view are divided into two major groups: (1) primary or idiopathic generalised epilepsy and (2) secondary or symptomatic epilepsy. In the primary generalised epilepsies the aetiological abnormality is generalized and affects the entire brain. This abonormality is usually genetic or constitutional in origin with low seizure threshold. This abnormality is normally not demonstrable or apparent and therefore, routine investigations do not reveal any lesion. As mentioned in the chapter on mechanism, the abnormality results from electrophysiological neuronal organization, and is evidenced by electroencephalography. Symptomatic or secondary type of epilepsy results from some local pathology within the brain. They have normal seizure threshold before the development of symptomatic epilepsy. Of the symptomatic group it is important to delineate a small sub-group—transient seizures occurring during the course of short illness or biochemical or metabolic insuits to the brain. Correction of the underlying disorder would not lead the recurrence of seizure and therefore, these persons do not require prolonged administrations of anti-epileptic drugs. Occasionally these may inflict structural brain damage and subsequent formation of epileptogenic focus and would require attention like symptomatic epilepsy.

Those epilepsies which originate from a focus of brain lesion are spoken of as focal or more properly partial epilepsies. The term 'partial' is preferable since the occurrence of a clinical seizure inspite of origin from a focus requires the involvement of a neuronal network for its spread. Focal lesions in the brain in the experimental animals can be produced by many physical, chemical or electric stimulation. All parts of the brain are not equally susceptible to stimulation, some more than the others. In certain highly susceptible areas of the brain, such as the temporal lobe repeated electrical stimulation over a period of days will lead to the establishment of an epileptic focus. Thus focal epilepsies represent the electrical overactivity of a part of the brain. In man, the focal lesions can result from structural defects, trauma, infections, neoplasms, metabolic disorders and vascular lesions etc. However, it is not always possible to demonstrate or identify the focal lesions in partial epilepsies. From the functional diagram of the brain (Fig. 1) it is easier to understand clinical manifestations from the location of the lesion in the brain. However, it is not infrequent that the focal manifestations of the partial seizures are missed or not observed by the patients or their relatives. Sometimes these are not told to the doctor as they are not considered important. Sometimes the interval between focal manifestations and the generalisation of the seizure is so short that only a very keen, knowledgeable observer, can appreciate and note them. Whatever be the reasons for not observing focal manifestations in partial seizures the EEG is very helpful in picking up focal abnormality. Sometime, special EEG techniques are required to identify the focal abnormality where routine EEG has failed. Any part of the cerebral cortex or subcortical structures can be the source of origin of a partial seizure. The commonest site is the temporal lobe followed by frontal, parietal, occipital lobe and subcortical structures in that order.

All partial seizures may not remain confined to one side. Many times they become generalised. This group of epilepsy is called partial epilepsy with secondary generalisation. If the initial focal manifestations in this form of epilepsy are not recognised, then they may resemble primary generalised epilepsies. This form of epilepsy also includes those that are associated with diffuse neuronal disease. Focal manifestations from the origin of epileptogenic focus may be appreciated in the secondary generalised epilepsies and may resemble partial epilepsy with secondary generalisation. Thus secondary generalised epilepsies are often manifested by partial, or myoclonus and a multiplicity of seizure types. They are seen in storage diseases of the brain, inborn errors of metabolism and viral encephalitis. Thus epilepsies can be classified as follows :

1. Primary or idiopathic generalised epilepsies.
   - Tonic-clonic (Grand-mal)
   - Absence (Petit-mal)
   - Myoclonic
2. Partial seizures.
   - (a) Partial simple
     motor, sensory.
   - (b) Partial complex
     Temporal lobe (TLE) or limbic lobe epilepsy
3. (a) Partial seizures with secondary generalisation
   - (b) Secondary generalised epilepsies.
     —Cerebral lipidosis
     —Poliodystrophies
     —Tuberous sclerosis

Epilepsies however, have been classified in many different ways incorporating the aetiology, pathological lesions, clinical features, electroencephalographic abnormalities, therapeutic response and prognosis. In many instances the clinical form of epilepsy may reflect a combination of these factors. No single classification incorporates all features and all types of epilepsy and therefore, is not satisfactory. The hallmark of generalised epilepsies is bilaterality and loss of consciousness in contrast to unilaterality and retention of consciousness in partial seizures. In partial complex epilepsy the consciousness is not lost but impaired or altered. Some people have used terms like major or minor seizures. These have not been properly defined but merely reflect their descriptive and clinical appearance. Minor and mild terms are intermixed.

For descriptive purposes the seizure can be said to have three phases: preictal (before the attack), ictal (attack itself) and postictal (after the attack). Though all forms of epilepsy may not exhibit all three phases but it is very important for the relatives and other witnesses to observe the attack under these three phases. It is needless to emphasize that the diagnosis of epilepsy is arrived at almost cent percent by histories narrated by relatives or witnesses. This diagnostic contribution will yield very high dividend if observations are recorded under these three headings. In the preictal phase the patient may have prodromal symptoms a few hours or a few days before the actual occurrence of seizure or ictal event. The patient gets some warning, awareness or sense of oncoming of a seizure. These may be mood changes, apprehensions, depression, disturbance of autonomic function, dyspepsia, constipation diarrhoea, uneasiness, irritability, headache, insomnia, muscle twitching or sensory phenomenon as the prodromal symptoms. Prodromal symptoms are not present in all forms of epilepsy and all the time in one form of epilepsy in an individual. The longer the patient has had epilepsy the more likely it is that, he becomes aware of prodromal symptoms and learns to associate a set of manifestations with the oncoming of a seizure. They have a beneficial purpose and a few patients discover means of preventing the seizure like by rest or by modifying the work schedule or by taking an extra dose of medication. They also learn to avoid hurting themselves. Prodromal symptoms are usually stereotyped and repetitive in an individual and thus can predict the day of occurrence of seizure. Mechanisms of prodromal symptoms are not well understood but may represent the accumulated effects of increasing subclinical seizure discharges and accompanying biochemical changes.

Ictal phase consists of seizure itself with motor, sensory, psychological and sensorial disturbances. Aura is the initial consciously remembered ictal part of the seizure and therefore, this the patient can recall subsequently. Aura should be differentiated from prodromal symptoms. Prodromal symptoms have no localising value but may represent the underlying preictal biochemical changes occurring diffusely in the brain. Aura may be constituted by a motor, sensory autonomic or psychical event. The aura indicates the site in the brain where the seizure originates and has thus localizing value but does not tell the nature of the underlying pathological lesion.

Postictal phase begins with the cessation of convulsion and lasts till the patient recovers completely. Postictal phase is also called the negative phase of seizure. Duration of postictal is very variable from a few minutes to a few hours. Duration of the postictal phase is dependent on many factors-some known and many unknown ones. Amongst the known factors are the type of epilepsy, severity of the seizure, frequency of seizures and recurrence, the underlying neuronal abnormality and pathological lesion, and age of the patient. Many times it is difficult for the relatives and witnesses to perceive postictal phase because of short duration and nature of manifestations. EEG may help at times to identify this phase by the presence of generalised background slow activity. Postictal manifestations may include vomiting, confusion, abnormal fumbling movements, headache, backache, bodyache, sleepiness, a staring look, generalised weakness and transient paralysis (Todd's paresis). Duration of Todd's paresis may vary from a few minutes to a few days. Among these postictal manifestations some have more definitive value and these are confusion, fumbling or searching movements,staring and unresponsiveness, and Todd's paralysis. Presence of postictal symptoms in a patient is useful for the diagnosis of epilepsy and in differentiating genuine epileptic seizure from non-epileptic seizure, while aura is important in identifying the site or origin of seizure. The pathophysiology of postictal manifestations is largely dependent on the neuronal exhaustion. All forms of seizure do not have all the three phases. Presence of phases will depend, beside unknown factors, upon the maturation of the brain and the balance between inhibitory and excitatory systems. Seizures in neonates are usually fragmentary and so develop or occur in sequence as in older children and adults.

Now I will describle briefly some common forms of epilepsy with salient features. This is of particular importance and is aimed for the patients and relatives to identify more than one form of epilepsy that may co-exist in an individual patient. Type of epilepsy may change in an individual as one grows older. It is very relevant and of utmost importance to appreciate that all forms of epilepsy do not equally respond to the same drug.

Tonic and clonic seizure (Grandmal)

This is not the commonest type of seizure but most commonly witnessed epilepsy seen on the roads or in the shopping areas or in public assemblies. This form of epilepsy is rather unmistakable by a majority of the people. Events are very dramatic and leave almost permanent impressions upon the witnesses. Tonic and clonic epilepsy is the best example which can have all the three phases, preictal, ictal and postictal. However, many do not have all the phases. The person who is walking or standing is seen falling on the ground suddenly. First comes the tonic phase with stiffness of all limbs and trunk muscles lasting for a few seconds. This may be associated with a loud cry, cyanosis, following voiding of urine, biting of the tongue or other injuries. Tonic phase is followed by the clonic phase which lasts for a few minutes. During the clonic phase colour returns, pupils dilate, pulse becomes rapid and sweating is profuse. During the tonic and clonic phase the patient is unconscious. The patient does not regain consciousness immediately after the ictal phase is over but exhibits a period of confusion and disorientation. Following this stage some patients recover while others go to sleep for a few hours. They wake up with headache, bodyache and generalised weakness but with a clear mind. Tonic and clonic seizures can occur at any age and may be both idiopathic or symptomatic. Majority of the idiopathic ones begin in adolescence or in teens. In the post middle age group, onset of tonic-clonic seizure with postictal Todd's paresis should be investigated for an underlying space occupying lesion. The EEG may show bilateral synchronous spike and wave discharges. There is usually good response to anti-epileptic drugs. Their frequency is relatively much less.

Absence seizure (petit mal) :

Absence seizures are very rare below the age of 5 years and above the age of 15 to 20 years. True absence epilepsy is uncommon much less than the tonic-clonic epilepsy. A child may have hundreds of attacks in a day. Each attack lasts for 5-10 seconds during which the child is motionless, loses consciousness with staring eyes. So the child does not fall and the eyes may blink rapidly. There are no movements of arms or legs. Consciousness is suddenly regained, the child looks around for a moment and then resumes his previous activity. These episodes may not be appreciated or registered by parents and friends. These attacks lead to lapses in memory and concentration. Teachers should be aware of these attacks and many times are the first to advise the child to seek medical help. These episodes may be mistaken for day dreaming. Child is of normal intelligence and does not have any neurological defects. Absence seizures are associated with classical bilateral, synchronous 3 cycles spike and wave discharges in EEG. Both clinical attacks and EEG abnormality can be provoked by overbreathing. This form of epilepsy may remain unidentified and may lead to poor scholastic performance which itself should indicate the need of neurological consultation. This form of epilepsy even if it remains unidentified and untreated ceases to occur after adolescence or after about 20 years of age, but then may merge into other types of epilepsy which obviously manifests and cannot be ignored for to be recognised. It is also true that absence seizures may co-exist with other forms of epilepsy for which medical help is sought and absence seizures are either recognised by the doctor after going through the patients history or after EEG examination is carried out. These absence seizures should be differentiated from complex absences which are accompanied by smacking of the lips licking, chewing or limb movements. Complex absences can occur at any age and are associated with different type of EEG abnormality. This form of epilepsy can be treated very effectively by specific drugs.

Partial (Focal) seizures

As already stated any part of the cerebral cortex or subcortical structures may be the source of origin of a focal seizure. Commonest site is the temporal lobe followed by parietal, frontal occipital lobe and subcortical structures in that order. All focal seizures have an underlying pathological lesion which is however, not demonstrable in all cases. The nature of the underlying pathological lesions will vary and is largely dependent on the patient's age at the time of the onset of the epilepsy. The typical focal motor fit begins with repetitive twitching of the angle of mouth, cheek, thumb, fingers and finally spreads to one side. The focal discharge begins in the contralateral i.e. opposite motor cortex. The discharge may remain confined to one side as unilateral partial seizure or become bilateral with loss of consciousness i.e. partial seizure with secondary generalisation. In partial unilateral seizures consciousness is retained. If the discharge shows typical march in a sequential manner with orderly involvement of the adjacent area on the same side of the body, it is known as Jacksonian seizure and is of relatively rare occurrence. EEG may show focal abnormality in partial seizures which may consist of spike or sharp wave or spike and slow wave complex in the contralateral hemisphere. Focal motor seizure with clonic contractions (alternate contraction and relaxation) of one group of muscles or limb may occur repeatedly and persist for several hours or days. This is called epilepsia partialis continua (EPC). In EPC the convulsive movements are not abolished during sleep. It usually remains unilateral and there is no impairment of consciousness. Generally partial seizures are difficult to treat and EPC in particular is resistant to usual antiepileptic drugs.

Partial complex seizure (Temporal lobe epilepsy)

Complex partial seizures may occur from the focus either in the frontal lobe or temporal lobe and is therefore, not synomynous with temporal lobe epilepsy as was considered in the past. Partial complex seizure may have motor, sensory, psychological, autonomic symptoms. There is impaired or altered sensorium but there is no loss of consciousness. There may be visceral olfactory (smell) and gustatory (taste) sensations, vertigo, auditory and visual hallucinations, autonomic phenomenon, disturbance of thought, perception and emotions. Automatism-simple or complex behaviour and actions during the attack without being aware is a very characteristic feature of partial complex seizure. At times this symptom complex is unfortunately misinterpreted by observers and by spurious bealces and quacks. The duration of automatism is usually brief and rarely it may be prolonged. Lip smacking, chewing, licking, swallowing movements, fumbling movements, picking of clothes etc are also seen in the partial complex seizure. Partial complex seizures are at times difficult to diagnose clinically as they may simulate psychiatric disorders. EEG shows focal abnormality in fronto-temporal areas. The EEG abnormality begins in the fronto-temporal area and then may become generalised. The generalised discharge may even last for several hours and results in a state known as 'twilight state'. Partial complex seizures may also lead to complex absence. There are some special types of partial complex seizures like cursive (running), gelastic (laughing), hypergraphic (writing) etc in which there is excessive uncontrollable running, laughing or writing. Complex partial seizures may occur at any age and may or may not have demonstrable underlying lesions. Partial complex seizures are much more frequent than the tonic-clonic seizures. Control of partial complex seizures may not be as effective as other forms of epilepsy.

Myoclonic seizures

The most characteristic feature of this form of epilepsy is the presence of myoclonic jerks-sudden shock like contractions of a group of muscles or part of a limb or whole limb or body. Myoclonic jerks may also include head nodding and forward or backward bending of the trunk. For several months and years these children may drop things from their hands and frequently break cups, glasses, pens etc. They have difficulty in brushing teeth. Parents of these children consider them fidgety and clumsy, and the cause of these behavioural disorders is unrecognised untill the child experience a major attack and loses consiousness. Myoclonic jerks may lead to frequent falls but the person does not lose consciousness and stands up soon. Myoclonic epilepsies are of several types. Myoclonic jerks may precede the tonic-clonic epilepsy or may be associated with other forms of epilepsies. Myoclonic seizures may occur from various encephalopathies and diffuse neuronal diseases. Benign myoclonic jerks occurring in normal persons during sleep should be differentiated from myoclonic epilepsies. Myoclonic jerks can occur at any time of the day or night but are more frequent soon after awakening. Myoclonic seizures occurring in infancy and childhood are generally associated with other forms of epilepsies and frequently associated with mental retardation. Such myoclonic epilepsies are generally very resistant to antiepileptic drugs. On the other hand myoclonic epilepsies seen in adults are very responsive to drugs but tend to recur on stopping drugs. Myoclonic epilepsies are associated with characteristic EEG abnormality.

Febrile Seizures

The prime determinant of febrile convulsion is fever, present before the onset of convulsion and the rectal temperature is about 38°C. There should not be any intracranial infections. The source of temperature is usually extracranial infections—viral, bacterial etc : from mild non–specific infections like pharyngitis, tonsilitis or upper respiratory infection to serious specific exanthematous infections. Intracranial infections may also give rise to convulsions but are not called febrile convulsions. Some children develop temperature in the postictal period, these convulsions are also not called febrile seizure. At times the source of infection may not be apparent.

Febrile convulsions are rare before the age of six months and after the age of 7 or 8 years. Highest incidence is in 9 to 18 months period. If one has not developed febrile seizure by five years of age it is very unlikely that he will develop febrile seizure. The incidence of febrile convulsions is about 5 per thousand per year. 30 to 50 percent children with febrile seizures show genetic predisposition. These children have genetically determined low seizure threshold to which further reduction in the threshold is added due to immaturity. The convulsions are brief but may be prolonged. They are usually tonic-clonic with loss of consciousness but may be focal or unilateral. Generally a single convulsion occurs at the peak of temperature. Boys outnumber girls by 3 to 2. EEG done after seven days of seizure shows normal trace. Abnormal EEG is not considered by many as representative of true benign febrile seizure. Ten percent children with febrile seizures atleast develop other forms of epilepsy in adult life.

Reflex Epilepsy

Reflex epilepsies are those epilepsies which are precipitated by a clearly recognised sensory stimulus. Sensory stimulus may be varied nature like light, music, reading, hot water etc. Auditory and visual stimuli are most common. Seizure resulting from these stimuli may be of different forms like tonic-clonic, myoclonic or even focal or in combination. Photosensitive or television epilepsy is one of the best examples of reflex epilepsy. Photosensitive epilepsy is naturally seen in animals also. Any strong and interrupted light may precipitate an attack. In the laboratory photosensitive epilepsy can be studied by intermittent photic stimulation. Self induced photic epilepsy provoked by hand waving in front of eyes is of special interest. Avoidance of precipitating factor is an important means in controlling reflex epilepsy.

Psychogenic seizures

The psychological or hysterical attack is most frequently seen in young individuals both in girls and boys. The hysterical attack

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is usually related to a situation. There is usually motivation for some gain. The hysterical attack usually occurs in the presence of people or rather it is exhibited. The attacks are prolonged and intermittent, and nonstereotyped i.e. variable pattern. The individual thrashes aimlessly and vocalizes which is characterized by respiratory grunts. In the 'unconscious' state of the hysterical seizures the patients may show some responses to the environment. They may hear and recognise others voices but usually do not respond. Postictal manifestations are singularly absent in psychological seizures. EEG done during the seizure does not show any abnormality.

Status Epilepticus

One of the ways of presentation of epileptic seizures is status epilepticus. Status epilepticus is defined as recurrent fits without regaining consciousness in between the attacks thus leading to epileptic state. It should be differentiated from recurrent attacks or a series of attacks when the patient is conscious in between the attacks. Two or more attacks leading to status epilepticus has different connotations as far as management is concerned as against a dozen of attacks or more constituting recurrent attacks. Status epilepticus is one of the medical and neurological emergencies requires prompt; vigorous and adequate treatment. All types of seizures can lead to status epilepticus. Status epilepticus are of three types: convulsive, non-convulsive and unilateral status (epilepsia partiales continua). The commonest cause of status epilepticus is when a patient stops taking his drugs. Other causes are concurrent febrile illness, drug interaction and toxicity, ineffective and undermedication. Status epilepticus can be the presenting manifestation of a tumour particular in the middle aged persons. Status epilepticus may lead to serious complications and high mortality of it remains untreated.

Precipitating factors in epilepsy

Many 'stress' factors can provoke seizures in susceptible individuals or in patients who have well controlled epilepsies. These factors are: lack of sleep or sleep deprivation, awakening from sleep, physical or mental exertion, emotional upsets, febrile illnesses, minor surgical procedures etc. Those individuals who have epilepsy trait i.e. no seizure yet but have genetic predisposition, may develop a seizure following some precipitating factor and then no recurrence subsequently for months or years, should not be labelled as epileptic. Precipitant provoked seizure is also called "stress seizure". One may condon stress seizures in the total management of epilepsy. Stress precipitating factors should be avoided as far as possible for the good management of epilepsy.

DIAGNOSIS

THE FIRST QUESTION to be answered in each case is whether a person has got epilepsy or not and thus to arrive at a correct diagnosis. There is a good clinical guide applicable to seizure characteristic in general that the seizure phenomenons tends to be brief, repetitive and stereotyped. Epilepsy is a paroxysmal and recurrent cerebral disorder. For the correct diagnosis of seizure it is most important to know what happens before (preictal) and after (postictal) the seizure rather than what happens during the seizure (ictal). Postictal manifestations have very diagnostic value. The diagnosis of epilepsy in majority of cases is only made or should only be made on history. Therefore, patient's relatives and witnesses should record their observations in as much detail as possible in sequential manner for proper narrating to the doctor. Correct but unexaggerated observations go a long way in arriving at a correct diagnosis. Needless to say that history and clinical examination should not be bypassed by investigation howsoever sophisticated it may be. It is estimated that about 15 to 20 percent of the patients referred to special epilepsy clinics are non-epileptic. It is very heartening and solacing for the doctor to diagnose correctly non-epileptic patients, thus taking away the long committed treatment besides the stigma of epilepsy. It is very disheartening for the doctor to diagnose a patient as epileptic who is not. One should not feel ashamed for not diagnosing a person initially as epileptic who is epileptic for lack of definitive evidence in the history. This person will be diagnosed later correctly by the occurrence of second or subsequent seizures and therefore, nothing much is lost in most situations.

Syncope, breath-holding spells, cataplexy, psychological seizures, cardiac arrhythmia with loss of consciousness should be excluded. In early infancy the diagnosis is often overlooked because of subtle character of the seizure. The expression of the infantile seizure may be unusual eye-blinking, irregular limb movements or apneic episodes. Myoclonic jerks are often mistaken for a normal startle reaction. In early childhood seizures are often confused with breath-holding attacks or syncope. Children in the age group of 2 to 4 years when in tantrum withhold their breath resulting in a change in colour, sweating and fainting. Syncope does not usually occur when the person is sleeping or recumbent, and is usually triggered off by a painful or distressing situation. The onset of syncopal attack is not as sudden. There is weak pulse, pallor or sweating, injury is uncommon, return of consciousness is rapid and there is no postictal confusion. In adolescent and adult people hysteria is the most difficult differential diagnosis. Hysterical attacks are not stereotyped and movements are not synchronous. People exhibit them initially for some gain. Detailed questioning reveals that in the 'unconscious' state patient responds to the environment. Cataplexy and migraine sometime come in the differential diagnosis. Seizure late in life may be due to brain tumour, cerebrovascular disease and occasionally degenerative diseases. Types of seizure will not distinguish the aetiology. Sudden drop attacks with unconsciousness for a while in the past middle age group is a difficult problem. Bradyarrhythmia and epilepsy both may lead to drop attacks.

The second question after having established the diagnosis of epilepsy is to know the type of epilepsy. Parents and relatives may not find this difficult to distinguish and enumerate different types of seizure that a person has got. Doctors should also ask the parents of each patient "in your opinion all seizure are of the same type or different types : if different then how many types". Some important types of epilepsy have been described in earlier chapters and hopefully patients should be able to identify some of these. Differentiation of seizure types is very important because different types of epilepsy respond to different drugs and differ in prognosis. It is not unusual when different forms of epilepsy are revealed or become obvious during the course of treatment for one type of epilepsy. It is an indication to enquire for other forms of epilepsy concurrently existing when one form of epilepsy is appropriately treated but is not controlled. It is known that carbamazepine may occasionally convert secondary generalised seizures into myoclonic or akinetic forms. The most common error is failure to distinguish true simple absence from the complex partial seizures of temporal lobe. Other seizure types which pose problems in identification are : complex absences and myoclonic epilepsies.

The third question to be answered in each case is whether the seizure has a focus i.e. focal epilepsy with or without generalisation or it is generalised epilepsy. Focal epilepsy can be identified by the aura or the initial focal manifestations. Focal symptoms may include turning of neck and eyes to one direction, twitching of the angle of mouth, paresthesia in thumb or index fingers, blindness in one eye or speech arrest etc before the onset of seizure. Focal features may be absent in one seizure while may be present in the next seizure in the same patient. At times focal features are brought out during the course of treatment. EEG is generally of great help in demonstrating or confirming the focal onset. Focal epilepsies are at times difficult to treat. When contemplating surgery in the uncontrolled epilepsies, the demonstration of an epileptic focus is of paramount importance.

The fourth question to be answered is whether the epilepsy is idiopathic (primary) or symptomatic (secondary). The general rule is that most of the focal epilepsies are symptomatic though the underlying lesion may vary. Among the symptomatic epilepsies all are not surgically treated ones. Trauma, infections, vascular malformations, tumours and other space occupying lesions, birth defects and degenerative diseases may cause underlying lesions in the symptomatic epilepsies. To unravel these lesions a set of investigations will be required. Most of the generalised epilepsies on the other hand are either idiopathic or due to diffuse neuronal diseases. The latter is never the indication even in the presence of focal features present occasionally for any surgical treatment.

The fifth question to be answered in each case is whether there is any associated neurological deficit or associated systemic disease (other systems of the body in addition to brain). Important associated neurological deficits are : mental retardation, autistic children with behavioural problem, paralysis, ataxia, involuntary movements, visual disturbances etc. Systemic organs commonly involved and of importance are liver, spleen, kidneys, bones and endocrine glands. The best examples are hypoparathyroidism, mucopoly-sacchrid and lipidosis. General and systemic examination is therefore, necessary in every case. Special investigations are required to establish these conditions.

The sixth question to be answered in each case is to know the impact of seizures on the patient's scholastic, social and vocational adjustments. This has got great bearing on the total outcome of any planning for the successful treatment.

ELECTROENCEPHALOGRAPHY

FIRST HUMAN electroencephalographic (EEG) recording was done by Hans Berger in 1929. In the following few years the clinical use of electroencephalography in epilepsy and brain tumours was reported by E.L. Gibbs, F.A. Gibbs, W.G. Lennox and P. Davis in U.S.A., by H.H. Jasper in Canada, and by W. Grey Walter and D. Williams in United Kingdom. From then onward the use of EEG had spread all over the world and was used practically in all neurological diseases. Electroencephalography for the clinical use of patients was introduced in India sometime in the later part of fifth decade. Electroencephalography today has got the maximum usefulness in the management of epilepsies. Advances in the averaging technique in last two decades have further increased its scope and applicability, and have given new dimensions. Electroencephalography by its wide use has been made very cheap and simplified. Electroencephalography provides a unique window through which one sees the functioning brain. It is very important to realise that a normal EEG does not exclude epilepsy and an abnormal EEG does not in itself indicate or confirm the diagnosis of epilepsy. EEG abnormality should be correlated with the clinical diagnosis and therefore, one must not solely rely on EEG to make the diagnosis of epilepsy in an individual patient.

Electroencephalography is safe and non-invasive and with which repeated evaluation of the brain function is possible. Electroencephalography (EEG) has the same principles as electrocardiography (ECG). In contrast to ECG machines, EEG machines have got large amplifires and filters to pick up relatively much smaller brain potentials. These electric potentials are largely generated by neurons (brain cells). Epilepsy is essentially an electric disturbance of the brain cells and therefore, EEG is most suitable for its study. These brain cell potentials are picked up by the electrodes placed on the intact scalp skin and recorded on the paper for later evaluation. No electric current is passed through the brain. Placement of electrodes has been internationally agreed and is called as 10–20 International pattern. Electrodes should have good contact with the skin for better pick up. Some jelly or paste is necessary between the electrode and skin to lower the resistance. For instance shampoo the hair and do not put any oil. This facilitates picking up the potentials. Different montages (pattern of electrode connections) are used to reveal greater abnormality from the specific areas. The actual recording should be done for atleast ten minutes. The trend to record few pages should be discouraged. Each patient should have provocative procedures done like hyperventilation and photic stimulation. Anticonvulsants should not normally be stopped for carrying out the EEG and also there is no need for the patient to be fasting. Sleeping tablets like benzodiazepines (valium etc.) should preferably be stopped two weeks prior to the EEG recording. Recording should be done in comfortable surroundings. High temperature and poor ventilation in the room may cause sweating and other artefacts and will result in a poor EEG. Very low temperature with shivering is also not productive. The patient should be resting in a comfortable chair, couch or bed. One should be relaxed. The most important aspect of a good EEG recording is, however, the requirement of a well trained and experienced technician who can with timely interaction apply necessary inputs while recording. This is necessary as the EEG records invariably are to be interpreted later in most of the laboratories. Technically poor records usually cause more confusion and wrong interpretations.

Electroencephalography may help in the diagnosis and delineating the type of epilepsy, may guide the therapy, may indicate the possible aetiology and may even suggest the prognosis, but the diagnosis of epilepsy should depend primarily on the detailed clinical history. All patients with epilepsy should have atleast one EEG examination when they visit the clinic for the first time. A second EEG (preferably sleep) should be obtained if the first EEG is normal and there is strong clinical suspicion of epilepsy. In most of the clinics ninety nine percent EEGs are recorded in between the attacks (interictal EEG). In a particular EEG, interictal seizure equivalent EEG abnormality may not occur during the recording time. It is possible that the abnormality has occurred a few seconds earlier before starting the recording or would have occurred if the recording would have been continued for a few more seconds. Thus a normal EEG does not rule out epilepsy. The value and expectation of electroencephalography are too exaggerated to the general public and general practitioners as well. Over-reading of EEG and over–reporting of EEG abnormality by specialists is even more dangerous and unwanted. There is a great need for all concerned with a patient with epilepsy to understand the limitations of electroencephalography.

EEG and Diagnosis of epilepsy

It has been made amply clear in more than one place that EEG should not be considered as the one and last tool for the diagnosis of epilepsy. However, EEG evidence of seizure should be sought at least once in the beginning in all patients. If the EEG recording happens to take place actually during the clinical attack, and shows no abnormality, it will suggest that particular attack as non-epileptic, one should remember that in a small number of cases epileptic and non-epileptic seizures may co-exist. What happens if the first routine EEG and second special (sleep EEG) turns out to be normal in a clinically definite epilepsy patient. This should suffice as for as the EEG investigations are concerned in a routine laboratory. One may, however, do special EEG studies which are discussed in the later part of this chapter. So EEG techniques like full nights sleep EEG, and EEG after sleep deprivation, which can be carried out in a routine laboratory, may be of value in some cases. Initiation of therapy should not, however, be delayed because of normal EEGs when the clinical situation so demands. It is true that the EEG abnormality may be found in normal persons or in clinically asymptomatic siblings or offsprings of a patient with epilepsy. It is, therefore, essential to remember never to diagnose epilepsy on the basis of a EEG, when there is no clinical history of seizure.

EEG and types of seizure

A detailed clinical history is again very useful in categorising various forms of epilepsy. The EEG may confirm the clinical impression. EEG may reveal the focal onset of the clinically generalised seizure or in partial epilepsies. Reflex epilepsies can also be confirmed in the laboratory by specific stimuli. In general one would be right to depend on the EEG for the type of epilepsy than for the diagnosis of epilepsy. The nature and morphology of EEG abnormality can be a guide to the type of underlying pathological process and thus may indicate the possible aetiology in some cases of epilepsy. The common EEG abnormalities observed are : hypsarrhythmia, spike and wave discharges, slow waves and spike discharges, 3 cycles spike and wave discharges, brief polyspikes and wave discharges, focal spike, sharp waves, or spike and wave complexes, paroxysmal runs of slow waves, periodic laterlized epileptiform discharges (PLED), generalised periodic discharges, and continuous abnormalities of status epilepticus. Some of the above patterns of EEG abnormality have been produced here for the readers appreciation (Figs. 3 to 7).

EEG and treatment

Many patients or their relatives have come to know the necessity for repeating EEG during the course of treatment. Similarly many treating doctors carry out EEG on their patients after every visit and every seizure. This is absolutely not justified. Once the patient is on antiepileptic drugs, the best guide for assessing the effectiveness and adequacy of therapy is the clinical history whether there is an attack or no attack, or the duration, interval and severity of the attack. There are however, some situations where repetition of EEG is indicated or justified. These situations are : trial of new drug, unresponsiveness to clinically contemplated appropriate drug, drug toxicity, multiple types of seizure not appreciated on clinical grounds, development of new seizure type, pre-operative assessment and for research activities With the clinical control of seizures one sometime likes to have or see the normalization of the previous EEG abnormalities. This is not always possible specially in focal abnormalities. EEG may remain abnormal or even get worse inspite of clinical improvement and the patient remaining seizure free. It is known that treatment of partial or partial complex seizure by carbamazepine can precipitate myoclonic jerks of generalised epilepsy. Similarly the use of benzodiazepines may bring out focal abnormality by suppressing generalised abnormality. These observations may guide the course of future therapy by suggesting modifications in the drug regime.

EEG and cessation of therapy

Many patients and clinicians too are inclined to have an EEG examination before stopping the antiepileptic drugs after an 'attack–free' interval is achieved. They are apprehensive about stopping the treatment. However repetition of an EEG at this stage is not at all necessary as cessation of therapy is based on clinical history and not on EEG abnormality. If EEG is done at this state and reveals the abnormality, it would necessitate and gear the physician to continue therapy with no guarantee that at a later period EEG would become normal or prolonged therapy would prevent the recurrence of seizure. Therefore, antiepileptic drugs should be tapered and stopped after a three year 'attack-free' interval irrespective of EEG findings. Some physicians advice their patients to undergo EEG examination periodically even where the EEG has normalized at the time of cessation of treatment. One should refrain from the temptation of treating EEG abnormalities at this stage in the absence of seizure. Therefore, repetition of EEG during the follow-up period after stopping the anti–epileptic drugs is not justified. Once the seizure recurs it demands a fresh appraisal as a new case of epilepsy requires.

EEG and Surgery

There is a very small number of patients with epilepsy who might be helped by operation. Surgical treatment of partial epilepsy is dependant on the demonstration of epileptic seizures originating in a circumscribed area of the brain. These areas are almost always localised in the cerebral neocortex and/or limbic structures. The purpose of electroencephalography is to demonstrate a focal onset of seizure activity. Routine EEG, even if it shows a focus is not sufficient and is therefore, not of great reliance. Persistent EEG abnormality even focal in itself is not the indication for surgery. These patients would always require special recording techniques such as sphenoidal or nasopharyngeal recording pre-operatively. At the time of operation these patients would require electrocorticography (electrodes are placed on the dura matter after removing the bone) or stereotactic depth recording (electrodes placed in the brain tissue). These facilities are only available in some selected neurosurgical centres which are engaged in the surgical treatment of epilepsies.

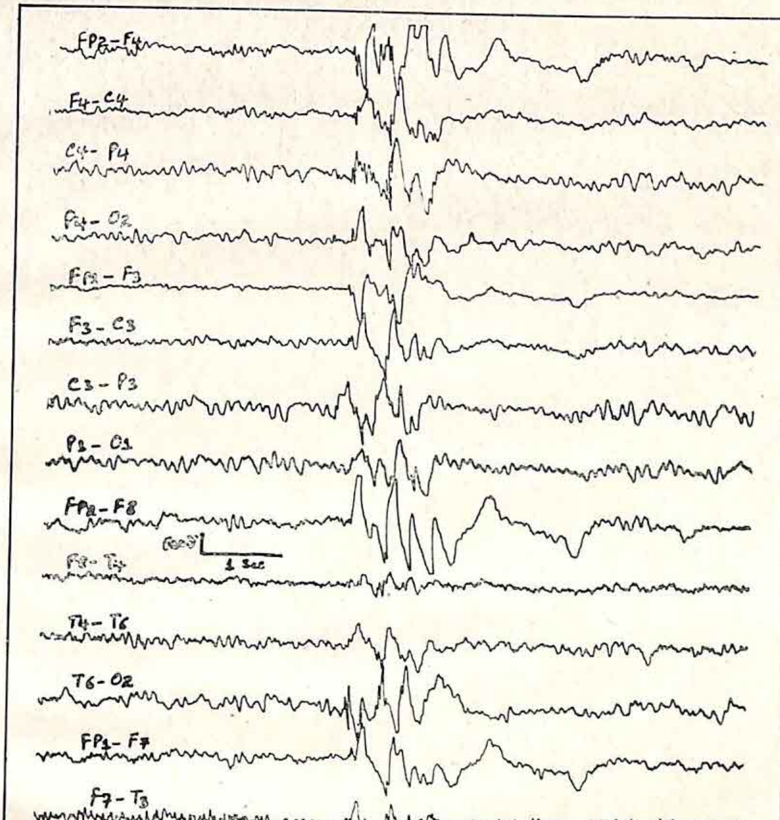

Fig. 3. EEG showing a generalised spike and wave discharge (Tonic-clonik-seizure)

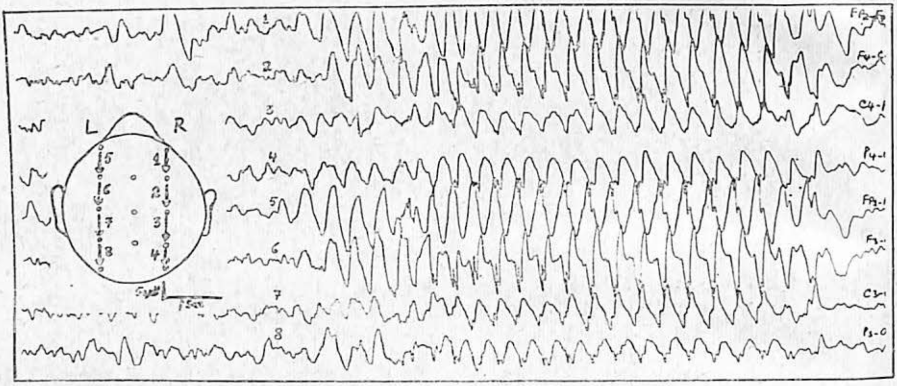

Fig. 4. EEG showing a generalised 3 cycles spike and wave discharge (simple absence)

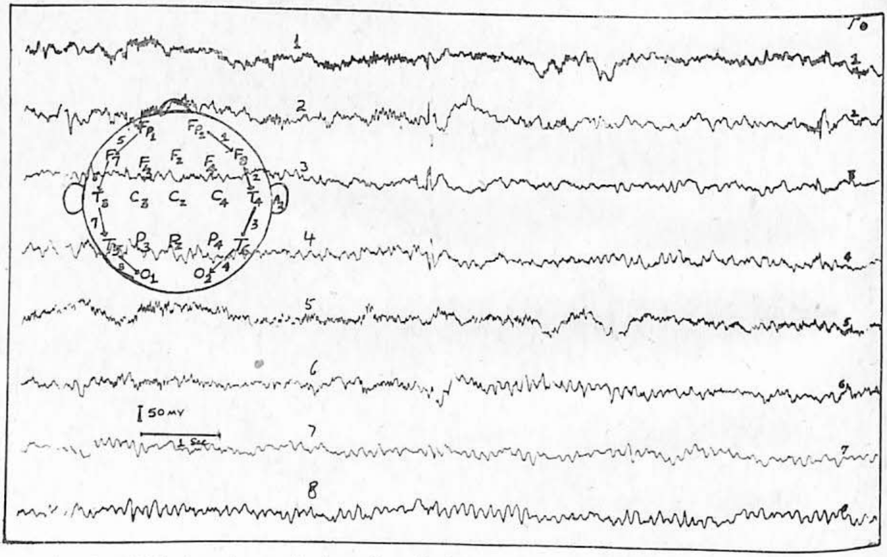

Fig. 5. EEG showing a single spike discharge with phase reversal in the right temporal region (partial complex seizure)

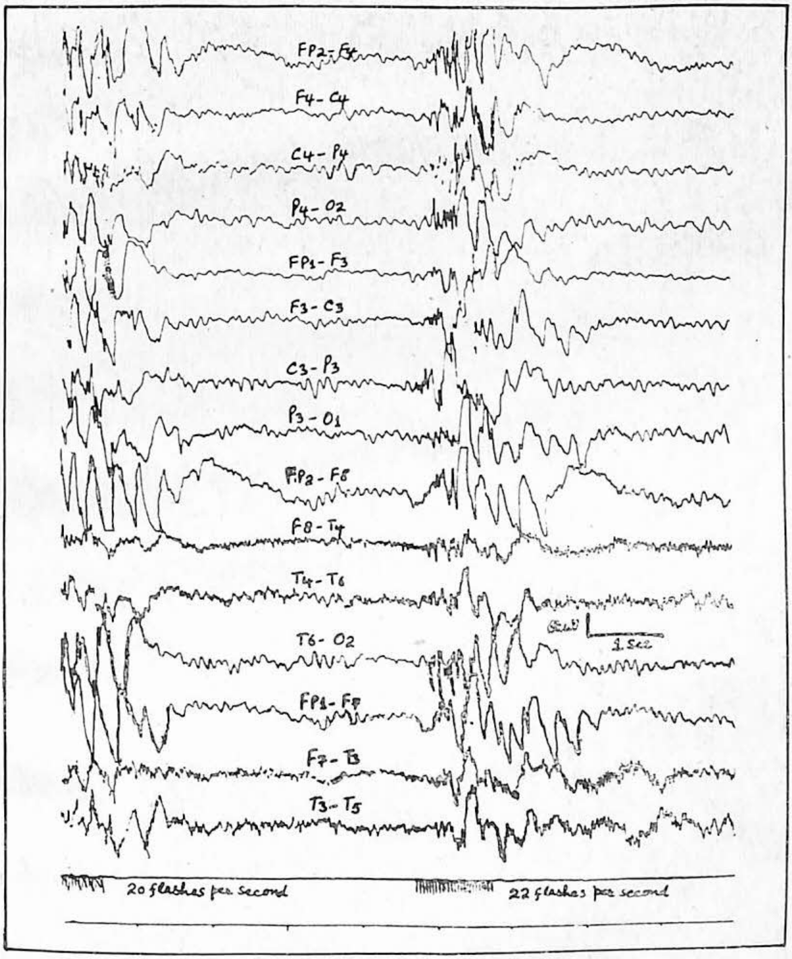

Fig. 6. EEG showing two generalised spike and wave discharges in response to intermittent photic stimulation (Reflex photogenic seizure)

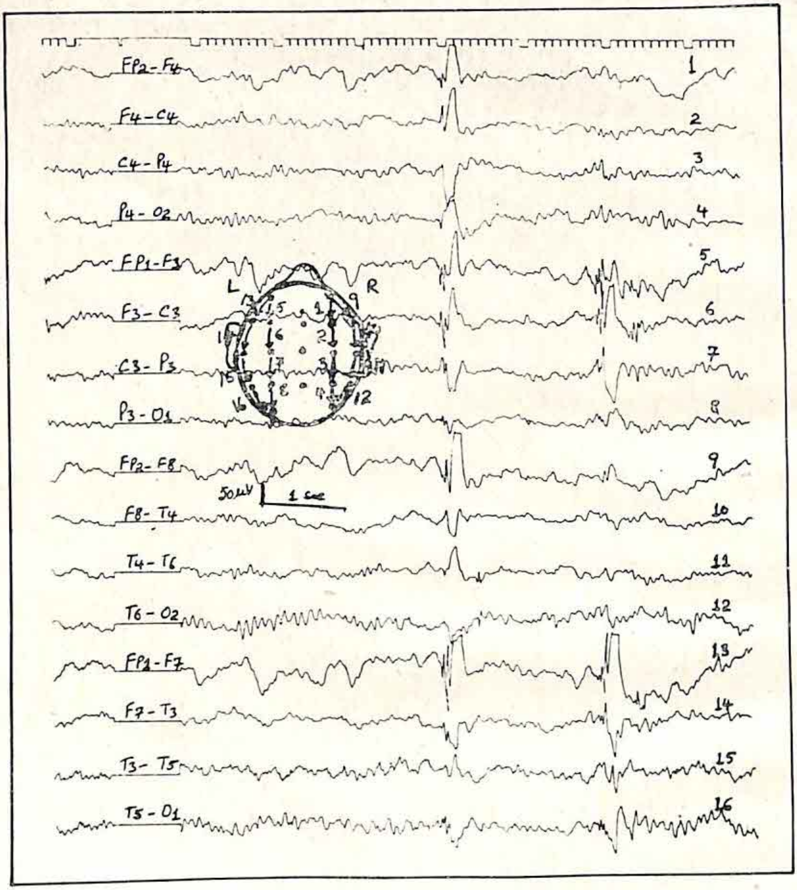

Fig. 7. EEG showing one brief, bilateral generalised spikes and wave discharge, and another on the left side only. This shows the advantage of many channels machine

Newer techniques

It has heen stated above that several routine EEGs may fail to show abnormality even in the clinically definite cases. There is always a diagnostic dilemma in drop attacks in the elderly and routine EEG invariably never helps. Finer details the seizure may not be appreciated even by very astute and keen observers. Relationship between multiple coexisting seizure types and multiple EEG abnormalities may not be very clear. New techniques are telemetry, EEG ambulatory, EEG and simultaneous video and EEG monitoring. Conventional EEG recording requires the patient to be attached to an EEG machine and to spend about 45 minutes in the laboratory for an actual 10 minutes recording. These new techniques have made it possible to overcome these conditions. Telemetry is the device for transmitting the EEG or other variables from the patient to the recording machine kept in the laboratory by radio waves. Radio transmission by frequency modulation and telephonic transmission have been in use. The patient should be within the range of the transmitter and this restricts the range of free movement. Then the technician should be available in the laboratory to pick up the signal and start the machine. For telemetry patients have to be admitted in the hospital. To overcome some of these shortcomings of telemetry EEG, ambulatory EEG has been developed. The development of small portable cassette recorders with recording time of 24 hours has enabled prolonged ambulatory recording. The patient can do all his routine work and need not be hospitalized. The recorded cassette is later transferred to the laboratory for display and recording for final interpretation. Further advancement has taken place in simultaneous video recording of the patient and EEG tracing. This is only possible for the admitted patients in special centres. These newer techniques are expensive. Cost-effectiveness per patient is very high. These newer techniques although required for a small number of patients provide maximum and definite information unthinkable from routine laboratory service.

EEG and other investigations

Computerized tomography (CT) and magnetic resonance imaging (MRI) demonstrate the morphological change in the brain but can not show functional alteration. EEG on the other hand reflects the function of the brain but not the structural change. Even in symptomatic epilepsy, function alters before structural change becomes apparent and therefore underlying lesion may be picked up earlier in EEG. It is now generally felt that CT and MRI, and EEG do not compete as far as epilepsies are concerned, but they supplement each other and provide a powerful combination of morphological and functional methods in the diagnosis of symptomatic epilepsies. Positron emission tomography (PET) is still in its infancy. These investigations will not replace the electroencephalography for the management of epilepsies.

INVESTIGATION

THE DIAGNOSIS OF epilepsy is primarily made on history obtained from the patient, relatives and witnesses. In the present era of diagnostic medicine with major reliance and dependence on modern equipment there is a tendency to bypass or shortcut the clinical history and examination. Still worse is the recent trend on the part of patients and relatives to investigate themselves even before the clinical examination. The results are obviously catastrophic. This is true in all clinical situations and epilepsy is one of the best examples. As a result many non-epileptic patients are treated for epilepsy. Once the treatment is started it is certainly a very difficult task for the other doctor to stop treatment.

Once a diagnosis of epilepsy is made then the next step should be to have EEG irrespective of the type of epilepsy. Some people argue about the necessity of EEG when the diagnosis of epilepsy is already made. In my view EEG evidence must be sought in every case of epilepsy. The reasons have been discussed in the chapter on electroencephalography. Symptomatic (secondary) epilepsies may be either focal or generalised. Pathological lesions underlying the symptomatic epilepsies are of very varied nature and include traumatic lesions, infections, infestations, vascular malformations, tumours, congenital malformations, degenerative lesions and metabolic and endocrine disorders. The list is large. The second point that one should keep in mind is that the majority of epilepsies are idiopathic (primary). Thirdly even among the symptomatic epilepsies there are only a small number of patients where specific therapy or surgical intervention is required. Fourth point of importance is that one should know the regional diseases which are more likely to be encountered. For example tuberculomas in the brain may be more frequent in India than anywhere in the western countries. Cysticercosis may be more frequent in some parts of India and less frequent or rare in other parts of India. There is no doubt that it is essential to know the underlying lesion to undertake full and effective therapy. It is a big decision to decide how far to go for investigation in an individual patient to reveal the cause. Newer and sophisticated techniques are very impressive and drain away a lot of money—This is particularly important in the developing countries and in the case of poor patients. There cannot be any guidelines except that the individual physician has to depend upon his intuition and clinical acumen to decide the quantum of investigations in the individual patients. Every investigation planned for an individual patient should contribute in the diagnosis either in positive or negative direction. Investigations are naturally directed by the clinical working diagnosis.

The common conditions to be kept in mind are : tuberculoma, abscesses, cysticercosis, tumours, tuberous sclerosis, arteriovenous malformations, cerebral lipidosis and hypoparathyroidism. The list is however, endless. Haematological and biochemical investigations are of value in revealing infections, blood disorders, hypoglycaemia, hyponatreaemia and hypocalcaemia and so on. Biopsy of the subcutaneous nodules or even brain may be required in a few cases. X-ray skull may indicate abnormality only in small number of cases such as increased intracranial tension, pathological calcification, abnormal vascular markings, bone changes like erosion or new bone formation, linear, depressed or widening fracture, cerebral hypoplasia or atrophy. Immunodiagnostic tests are being developed for tuberculosis, cysticercosis and toxoplasmosis. The examination of cerebrospinal fluid may be necessary in some cases. Angiography may establish vascular lesions. Computerized tomography (CT) has reached the door step of a large population all over the world. Cysticercosis and tuberculomas are easily picked up now by C.T. Computerized tomography is very sensitive in picking up calcification in much early stages. CT may also pick up tumours in early stages when there is no increased intracranial tension. Vascular lesion can also be identified. Magnetic resonance imaging (MRI) has further advanced our diagnostic capabilities. Positron emission tomography (PET) is still a research tool in a few laboratories of the world and may reveal even epileptic foci both during the seizure discharge and in between the seizures (interictal) period.

One however, should understand the limitations of these various technologies. If all these investigations are done in all cases of epilepsy even the richest countries in the world may not be able to afford or justify them. In the developing countries this is not practical. Presence of a lesion in computerized tomography or other investigations should be correlated with the clinical picture, and should not be taken blindly as responsible for a seizure disorder. Repetition of an investigation is indicated for follow-up in some patients and in a few situations. The responsibility of repeating the investigations should be left to the treating doctor. The treating doctor should only have clinical considerations for the benefit of the patient while repeating the investigations.

TREATMENT

THE MOST IMPORTANT aspect of the management of epilepsy is to remember whatever form of therapy is considered, that epilepsy is one such disease where therapy once started is committed for a long time, at times for the whole life either continuously or with short breaks. Most of the epilepsies with some exceptions are controllable but not curable. The second point of importance is that epilepsy in majority of cases affects an individual at a young age in the early part of life when one starts acquiring education, vocational training, new career and social responsibility. The third point of great importance is that prescribing medicines is only one of the several facets of total management of patients with epilepsy. The other facets of equal importance are vocational, psychological, financial and social aspects. The following forms of treatment are available for the treatment of epilepsies.

1. Medical
2. Surgical
3. General

1. Medical

The aim of treatment with antiepileptic drugs is to stop all seizures and to achieve complete suppression of all epileptic activity in EEG without producing side effects for a duration long enough so that the tendency to epilepsy ceases and treatment can be stopped. It is unlikely that this aim can be achieved at present in a large number of cases. Suppression of seizures is largely achieved by the development of newer and newer and more effective drugs in the 20th century. Bromides were used for many years in the 19th century until phenobarbitone was made available for clinical use in the year of 1912. Formerly, the aim of treating epilepsy was often regarded to be merely keeping the sufferer free of convulsions but the evergrowing contemporary hope for cure often entails a more vigorous and meticulous approach to drug therapy combined with social and rehabilitative measures. However, the aim remains restrictive and unrealistic in epilepsies due to progressive neuronal diseases and other developmental disorders.

1.1 General principles

Diagnosis : It is of utmost importance to make a correct diagnosis of epilepsy before instituting any drug therapy. The diagnosis of epilepsy should be based on positive criteria and not on negative criteria or by method of exclusion. If there is a doubt in the diagnosis it is much better to wait till some more evidence comes to light to establish the correct diagnosis. No harm is done to the patient in this approach in most case. Such a patient should be kept under observation. However, grave harm is done if treatment is started on a patient who does not have epilepsy. Doctors should not feel guilty and the patient should not conclude that the doctor is either negligent or incompetent in withholding antiepileptic drugs if the patient develops genuine seizures during the observation period. The patient and relatives should appreciate that making out a prescription is very easy for any doctor, in fact it is difficult to withold prescribing medicines in order to wait for the results of a dependable diagnosis.

Single attack : Single seizure, by and large, should not be treated specially if the two EEGs (routine and sleep) are also normal. If the abnormality is trivial then one should wait for the second seizure to occur. The reason for not treating the single attack is that the second attack may never occur, or may occur after several months or years. If the EEG is abnormal and the abnormality is definite, and the patients vocation is such that he runs a risk of hurting himself if he experiences a seizure while at work then one may be advised to start antiepileptic drug. The doctor should assess the risks of recurrence after the first attack in each individual patient. Single attacks may be symptomatic of an underlying treatable condition, and therefore, if the history is suggestive then the patient should appropriately be investigated for the underlying lesion.

Frequency of seizures : One should get as much information as possible and find out the total number of seizures and duration of epilepsy. Because of ignorance and prejudices many patients come to the hospital very late. Either they had not taken any medicine or had tried all sorts of indigenous medicines or other medical systems like Ayurved or Homeopathy etc.

Precipitating factors : Every patient should be asked about the precipitating factors like breath-holding, stress situation, pre-menstrual or menstrual, exertion, sleep deprivation, emotional upsets or starvation. Circadian rhythms and meterological phenomenon, full or no moon (amavashya) or eclipses can influence the precipitation or prevention of seizures through their physiological effects. Correction of these adverse influences can improve the effectiveness of drug therapy.

Severity of seizures : There is some misunderstanding on this aspect of epilepsy. Some people feel no necessity of initiating drug therapy if the seizures are mild and very infrequent. All seizures major or minor, occurring during wakefulness or sleep, focal or generalised, should be treated at par as far as the initiatio and continuation of drug therapy is concerned.

Types of seizure : Various forms of seizures should be established in each case either from the clinical description or from EEG studies or both. This is important because all forms of seizure do not respond equally to one drug.

1·2. Selection of an appropriate drug

As outlined above one must know the types of seizure, their severity, frequency and precipitating factors before selecting the ideal drug. Purpose of starting of antiepileptic drugs should be explained to all patients. There is one golden rule that the doctor should use only those drugs which he is familiar with. Doctors should get fully familiarised before prescribing any new drug that comes in his services. The present trend in prescribing new drugs indiscretely should be discouraged strongly. Choice of the ideal drug according to the types of seizure is listed in Table 1. When a particular drug is selected, the patient should again be informed all about this drug particularly its common side effects. The other very important consideration while selecting the drug is the cost. It is an unacademical but very practical point particularly in the developing countries, when the drug is to be taken for a long period. Once the drug therapy is initiated, it should be continued without any interruption for atleast three years to achieve a 'seizure-free' period. When the 'seizure-free' three year period is achieved, drug therapy should be tapered off in the next 2 to 4 months period. The patient needs to be told further at this stage what to expect after the discontinuation of therapy. Once the drug therapy is stopped there is no need to observe all the restrictions strictly and the patients regime can be relaxed some what one should hope for the best. The common causes of failure or poor response of antiepileptic drug therapy are listed in Table II.

1·3. Monotherapy v/s Polytherapy

For a variety of reasons patients with epilepsy are frequently treated by multiple drugs. Some of these reasons are : no single drug is effective for all seizure types; multiple seizure types co-existing in one patient; underlying lesions in some; temperament and demand of patient and doctor as well. If the first antiepileptic drug proves unsuitable or ineffective in a given patient then the doctors without giving due consideration to time or dosage tend to add a second or third drug and so on. Each time a patient visits the doctor with a history of recurrence of seizure, some other drug is added in this prescription with the belief that this would control the attack. Both doctor and patient should resist such a temptation as this does not work in majority of cases. On the other hand the patient will have multiple side effects in addition to the burden of cost of therapy. There is now abundant literature with strong evidence for advocating monotherapy. Polypharmacy has not helped in majority of the cases. Single drug should be selected for type or types of seizure for a given patient. The dosage should gradually be increased, either till the seizures are controlled or to the patient's limit of tolerance or therapeutic level of the drug is reduced. If the ideal drug fails then there is temptation to use the second drug, One is advised to take an alternative approach at this stage. It may be therapeutically better to withdraw the first unsuccessful drug gradually, after the second drug is added and increased to the therapeutic level. This alternative approach needs a little expertise and may not always be practical and safe without undue disruption of the patient's social circumstances. If the alternative also fails then the patient comes to receive multiple antiepileptic drugs. It is generally found beneficial to use two drugs in subtherapeutic doses rather than using one of the drugs in the toxic range. It is easier to avoid multiple therapy in the first place than to attempt to reduce multiple therapy later on. It is observed that about 60% of all patients with epilepsy can adequately be managed by one drug. Another 25–30% will require two drugs to achieve effective control of seizures. In about 10–15% patients adequate control may not be achieved even with three or more drugs. Experience has shown that various combinations and permutations of drugs are also of no avail in this 10-15% group of patients. There are some situations where patients continue to have seizures—particularly minor ones, in spite of adequate drugs and dosage. In such situations it is an individual's philosophical approach either to push anticonvulsants further to toxic levels with side effects or to advise the patient to carry on with minor seizures but without side effects. Either make the child drowsy and sleepy with impaired capacity, concentration and learning or to allow the child to have occasional minor attacks without aiming at 100% control and 'seizure-free', three year interval. It is really a very difficult decision. It is hoped that the development of better and more effective drugs may provide the answer.

1·4. Drug Schedule

Over the years pharmaceutical industries have provided most of the drugs that are to be taken three times a day. Doctors have got used to this prescribing habit. Better understanding of the principles of drug absorption, distribution, elimination and specificity has provided new outlook in the role of drugs in the last two or three decades. New information is available on the 'half-·life' of all antiepileptic drugs. 'Half-life' is defined as the time required to remove half of the active drug from the body. If the 'half-life' of a drug is more than 24 hours then that drug should be taken as a single daily dose. If the half-life is about 12 hours or 8 hours then the drug should be taken in twice daily or thrice daily dose respectively. Longer the 'half-life' means more days to reach the steady state. Principles of 'half-life' may not be applicable under conditions like infancy and early childhood, mental retardation and other pathological states, and individual tolerance. Experience has shown that the mid-day dose is most often forgotten by the patient and therefore, should be avoided. Single daily dose should be taken at bed time. Table III indicates that most of the drugs are used either in a single daily dose or twice a day. Some adjustment in administration schedule is more practical for better compliance and good control of seizures, than a several doses schedule with poor compliance and poor seizure control.

1·5 Monitoring of plasma anticonvulsant concentrations

With the strong contemporary advocacy for monotherapy it is very essential that one drug should be increased to the therapeutic level before deciding the ineffectiveness or effectiveness of the drug. When seizures occur frequently it is relatively easy to know by sheer reduction in numbers whether drug therapy is controlling the epilepsy. However, when seizures occur irregularly and infrequently, it is very difficult to establish the adequacy of therapy. This may be, however, done easily with monitoring the plasma levels of antiepileptic drugs. The important indications of monitoring the blood level of drugs are given in Table IV. The therapeutic range offers the average patient the best chance of controlling the epilepsy without significant risk of serious side effects. Figures for the therapeutic ranges of the antiepileptic drugs in common use are given in Table V. There are several methods to estimate the serum levels but today in most of the good laboratories gas liquid chromatography (GLC) and enzyme multiplication immunoassay technique (EMIT) are used. These methods measure the concentration of protein bound drugs. Blood levels to be useful should be accurate and reproducible. In recent years it is possible to measure free plasma drug concentration accurately on routine basis. However, free levels estimation have not been proven much superior than the bound levels. When seizures are under control with subclinical or average doses, the estimation of blood levels are not required and may be misleading, particularly with phenobarbitone and diphenylhydantoin. A fair number of patients with epilepsy in both developed and developing countries are being managed without monitoring the blood levels of antiepileptic drugs. Nevertheless the therapeutic ranges provide very useful guides to the therapy of human epilepsy. It must be emphasised, however, that the final criterion of successful management is the clinical response and not achieving of a plasma drug concentration within a particular preconceived range.

1·6. Drug Interactions

There has been much progress in the understanding of the pharmacokinetics and metabolism of antiepileptic drugs in the recent years. Numerous interactions have been described in which (a) a change in the dose of an anticonvulsant alters the plasma and tissue concentrations and the pharmacological effects of another drug taken concurrently, or (b) a change in the dose of another drug alters the plasma concentrations and the pharmacological effects of an anticonvulsant. The latter type of interaction is clinically first suspected when the anticonvulsant toxicity develops in a patient who has been taking a constant dosage for sometime without previous side effects. Anticonvulsant drugs can interact with each other and lead to the deterioration in the control of epilepsy or in the plasma drug concentrations. Anticonvulsant drugs may interfere and alter the effects of concurrently used anti-coagulants, antipyretics, steroids, antidepressants and others. It is observed that the benzodiazepines are involved in relatively few interactions, and that diphenylhydantoin is involved in major interactions which inhibit the drug's metabolism. One direct message from the above knowledge is to avoid polypharmacy in the management of epilepsies.

1·7. Follow-up

Doctor's responsibility does not cease at making the correct diagnosis and starting the therapy. Unlike usual ailments, epilepsy requires treatment for a long period. Patients must be seen at 4-6 week intervals until the seizures are controlled and adequate doses are reached. Subsequently patients should be called regularly for follow up at 3-4 months interval. One can question the wisdom for the need of regular follow-up. Experience has shown that regular follow-up will not only ensure the drug compliance but ensure the confidence in the patient, and also ensure the uninterrupted long period of therapy to be completed. Patients or the relatives should be requested to keep a record of the seizures regarding the number of seizures, time and duration of seizures, precipitating or association factors. Patients must be encouraged to bring this record at every follow up appointments. The author has found it particularly useful asking them the date of last seizure at each follow-up. This gives them hope and confidence that the expected date is not far off when the anti-convulsants will be stopped.

1.8. Side or adverse effects

All drugs used for human illnesses have unwanted adverse reactions. All anticonvulsant drugs have also side effects, trivial or major. No system of the human body is spared by these drugs and common adverse reactions of commonly used antiepileptic drugs are given in Table VI. Some of these adverse effects are common to more than one drug while others are peculiar and specific to individual drugs. It is advisable to educate the patient about the side effects. Some side-effects are dose related and others can be avoided by starting with smaller dosage and then slowly building up the required dose. To what extent these side-effects are permitted in an individual patient is a matter of several considerations including the cost of drug therapy.

1.9. Teratogenicity

Teratogenicity is defined as the effect of drug on the foetus and thereby producing malformations of the body. Teratogenic effect is produced by anticonvulsants both in sperms of male patients with epilepsy and in the ovum of female patients with epilepsy, or foetus. Teratogenicity is indisputedly well established with the trimethadione. However, there are many reports in literature about teratogenic effects of other antiepileptic drugs, for and against in the humans. Diphenylhydantoin is more often incriminated in producing teratogenic effect than other major antiepileptic drugs. Phenobarbitone comes next to diphenylhydantoin. Teratogenic effect of anti-epileptic drugs to foetus takes place in the first trimester of the pregnancy. Therefore, if pregnancy is planned, teratogenic drugs may be withdrawn and safe drugs should be substituted. Foetal abnormalities in some cases may be of genetic origin rather than due to antiepileptic drugs. Teratogenic malformations due to antiepileptic drugs in patients with epilepsy, however, occur in a small number of cases. Common malformations are cleft palate and hare lip. These are easily surgically correctable.

1.10. Duration of antiepileptic drugs

Why should antiepileptic drugs be stopped in a patient who has been seizure free for a number of years ? The major risk of discontinuing therapy is the recurrence of seizure. Recurrence of the seizure following the cessation of therapy has got major social, economical and psychological impacts. If the anticonvulsants are continued indefinitely, they may produce certain side effects, cognitive and other behavioural problems, teratogenicity, financial loss in the cost of drugs and visits to the doctors, and even more important the loss of confidence and ray of hope in these patients. If the anticonvulsants are stopped after a number of years of 'seizure-free' period should lead to confidence in the patient and many socio-economic gains. One has to review critically the incidence and risk of recurrence of seizures after cessation of antiepileptic drugs. Relapse rate after 'seizure-free' period of 2-4 years is about 25 to 30% in children and 40 to 50% in adults. What are the prognostic features which may predict which patient is likely to relapse when anticonvulsants are withdrawn ? Some factors like age of onset, sex, race, positive family history and age of cessation of therapy have no definite prognostic value. Other factors like delay in starting therapy, underlying neuronal diseases, mental retardation and neurological deficits, severity and forms of seizure and diffuse background slow activity in EEG have several fold increase in the probability of recurrence of seizure and thereby prognostic value. Most epileptic adult patients have complex partial seizures which atleast partially account for the higher relapse rate. There are varied observations between the relationship of the relapse rate and the degree of EEG abnormalities at the time of cessation of drug Definite paroxysmal abnormality in the EEG obtained just before the discontinuation of therapy is associated with several fold increased relapse rate. Some people do not take EEG at the time of discontinuation of therapy and the decision is primarily based on clinical history of 'seizure-free' interval. If EEG is obtained and shows definite abnormality then there is no choice except to continue therapy. When should discontinuation of the therapy be attempted after

2, 3 or 4 years of antiepileptic drugs and 'seizure-free' period ? I suggest a midcourse of 3 years period of seizure free interval prior to the start of drug withdrawl. The drugs should be tapered and gradually withdrawn over a period of 2-3 months. If seizures continue to recur inspite of optimally monitored drugs, there is no alternative but to continue treatment indefinitely, always ensuring that the treatment does not become more of a burden to the patient then his or her epilepsy.

2. Surgical treatment

All forms of seizure should be treated with an antiepileptic drug but an attempt should be made simultaneously to identify difficult to treat and other variations of the treatable epilepsies. Surgically treatable epilepsies should be identified. It should however, be appreciated that only a very small number of patients require surgical treatments. The second point to be appreciated is that the responsibility to decide about surgical treatment in a patient and thereby justifying referral to a neurosurgical centre, lies with the neurologist or epileptologist. The third point of importance is that this small number of patients considered suitable for surgery, require special investigations and special neurosurgical centres with capability to look after these patients. The fourth point to be remembered is that all difficult to treat or poorly controlled epilepsies are not suitable for surgical treatment. Good scrutiny is very essential for good results from the surgery. Surgical centres should ensure that various forms of surgery may be carried out without undue risk to life and without producing serious neurologic deficit. About 60% are benefitted by surgical treatment. The fifth point of great importance that requires to be appreciated, is that about 40-50% of the surgically treated patients would continue to require antiepileptic drugs though a fewer number of tablets. Different types of operations are designed for surgical treatment of epilepsies. These are temporal lobectomy, frontal lobectomy, limited cortical or limbic resection, selective amygdalo-hippocampectomy, corpus callosotomy and hemispherectomy and so on. Surgical units have to decide which type of surgery is required for the patient. Anterior temporal lobectomy is the commonest operation performed, and does not impair the patient's speech or memory. Cerebellar stimulation by means of implanted electrodes has been advocated in the management of intractable epilepsies. Cerebellar stimulation exerts an inhibitory effect on cerebral seizure activity. This is partly useful only in a few cases.

3. Other forms of treatment

The existence and use of other forms of treatment in the management of epilepsies is itself an indication that all types of epilepsy are not easily controllable. Searches in different directions have been conducted with the sole aim of helping the patient in controlling seizures. These various methods are undertaken not as the first sole method but as complimentary to drug therapy.

Ketogenic diet : Among dietary measures the ketogenic diet (High fat) has been found useful in the treatment of severe childhood epilepsies. How it helps is not well understood ? Ketogenic diet is not very palatable.

Conditioning and biofeed back : The principle of biofeed back method is aimed at the enhancement of a "sensorimotor EEG rhythm" with its presumed seizure-inhibiting effects. Conditioning methods are aimed to confine the seizure-triggering mechanism.

Electromagnetic therapy : Electromagnetic,field has been detected around each individual person. There are a few reports suggesting its influence on epilepsy. This needs further exploration.

Sleep regulation : Sleep disorders and epileptogenesis are very closely interlinked. Sleep and sleep deprivation have been used in the laboratories as provoking factors. Normalization of sleep disorders may help the EEG abnormality and control the seizures in some patients.

Psychotherapy and avoidance of stress : If there are stress induced seizures then it is sensible to reduce or avoid those stresses. Psychotherapy is effective in this direction in eliminating stresses. Some change in life style and occupation may also help in controlling seizures. Abstinence from alcohol and smoking, and avoidance of toxic substances may at times help some patients.

Other medical systems : Many indigenous methods and other medical systems claim to provide help to these patients. I feel there is no harm in trying these approaches particularly in those patients whose epilepsies remain uncontrollable. We have no scientific evidence to prove or disprove their claims. I, however, strongly advise not to lose time unnecessarily in persuing these methods and thereby delay the treatment.

Table I. Choice of drugs according to type of seizure

Type of fit	*Drugs in order of preference**
1. Tonic-clonic (Grand mal)	1. Phenobarbitone 2. Diphenylhydantoin 3. Carbamazepine 4. Sodium Valproate
2. Simple absence (petit mal)	1. Sodium Valproate 2. Ethosuximide
3. Complex absences	1. Carbamzepine 2. Diphenylhydantoin 3. Sodium Valproate 4. Nitrozepam 5. Clonazepam
4. Partial seizure	1. Diphenylhydantoin 2. Carbamazepine
5. Partial complex	1. Carbamazepine 2. Diphenylhydantoin 3. Primidone
6. Myoclonic	1. Sodium valproate 2. Nitrozepam 3. Clonazepam
7. Status epilepticus	1. Diazepam (i.v.) 2. Diphenylhydantoin (i.v.)

***Individual opinion**

Table II. FAILURE OF ANTIEPILEPTIC DRUG THERAPY

1. Incorrect diagnosis and form of epilepsy
2. Inappropriate drug or combination of drugs
3. Inadequate dosage
4. Poor patient compliance
5. Drug toxicity and interactions
6. Mental retardation and other underlying neuronal diseases

Table III. Frequency of drug administration

Drug	*Half-life (hours)*	*Steady state (days)*	*Administration schedule*
Phenobarbitol (PHEN)	36—40	14—21	Single daily dose
Diphenylhydantoin (DPH)	15—20	5—10	Single daily dose
Carbamazepine (CARB)	10—30	4—6	Twice daily dose
Sodium Valproate (SV)	8—18	2—4	Twice daily dose
Benzodiazepine			
Nitrazepam	20—24	4—8	Single or twice daily dose
Clonazepam	24—30	4—8	Single or twice daily dose
Ethosuximide (ETHO)	30—60	5—8	Single daily dose

Table IV. MONITORING THE BLOOD LEVEL

1. Effective and therapeutic level

To detect poor compliance

Drug toxicity

4. Drug interactions

Before initiating polypharmacy

γ

6. Research

Table V.

Drug	**Dosage**		*Therapeutic range*	*Toxic level*
	Children (mg/kg/day)	*Adults mg/day*	*(ug/ml or mg/litre)*	*(ug/ml or mg/litre)*
Phenobarbitone (PHEN)	1—5	60—90	10—30	40
Diphenylhydantoin (DPH)	4—7	300—400	10—20	20
Primidone (PRIM)	10—25	500	10—30	40
Carbamazepine (CARB)	7—15	1200	6—12	12
Sodium Valproate (SV)	10—60	1200	50—100	100
Ethosuximide (ETHO)	20—30	750	40—100	100
Nitrazepam	0·5—1	5—10	—	—
Clonazepam	—	2—6	0·025—0·075	

Table VI. Side effects of antiepileptic drugs

Drug	*Side effects*
Phenobarbitone (PHEN)	Drowsiness, aggression, irritability, poor concentration, hyperkinetic, impaired learning, skin rash.
Diphenylhydantoin (DPH)	Gum hyperplasia, Nystagmus, ataxia, acne, hirsutism, coarsening of facial features, dysarthria, skin rash, drowsiness, involuntary movements.
Carbamazepine (CARB)	Skin rash, giddiness, double vision or blurred vision.
Sodium Valproate (SV)	Nausea, vomiting, weight gain, loss or thinning of hair, tremors.

Drug	*Side effects*
Ethosuximide (ETHO)	Sedation, nausea, vomiting, behaviour disturbance.
Primidone (PRIM)	Same as Phenobarbitone
Benzodiazepine	
Diazepam (IV)	Sedation and respiratory depression
Nitrazepam	Sedation, drooling of saliva, dizziness
Clonazepam	Sedation, hypotonia, aggressiveness, ataxia

SOCIAL ASPECTS

EPILEPSY IS A MAJOR problem for any country. The prevalence rate shows some variation but on a very conservative estimation it varies from 0·5 to 1·0 percent or 5 to 10 per thousand of the population. Based on these figures there are about 35 to 70 lacs people of all ages and both sexes suffering from epilepsy in India. The incidence rate (new cases in a year) of epilepsy may suggest that 2 to 3·5 lacs children and adult are afflicted with epilepsy every year. Epilepsy is also one of the commonest neurological disorders in any community of the world. Epilepsy is a chronic illness and differs from many other common illnesses in many different ways. Drug therapy is prolonged and in 40 to 50 percent cases may be life long. Continuous daily drug therapy is required and poor compliance shows the effect quickly and easily manifests with recurrence of seizures. Such recurrences leads to frequent psychological, emotional, occupational and financial problems to the patients and their dependents. Cost of drug therapy shows a wide range from 10 paisa to 15 rupees per patient per day. It is not difficult from the above facts to conceptualize the magnitude of the problem and how best these problems can be sorted out with the sole aim to help out these patients with epilepsy.

Community

Community owes a great responsibility to these patients with epilepsy. Family members, relatives and neighbours need to be educated about the illness. Misconceptions, false beliefs, prejudice and ignorance must be removed from the society by proper scientific based education. Society should know what is to be done if one of their members gets a seizure. They should ensure a clear air passage by removing any obstruction, to prevent choking. The patient should be prevented from injuring himself and care should be taken that his personal belongings are not lost or stolen during the attack. Arrangements must be made to remove the patient to the hospital. A bitten tongue will heal but a broken tooth cannot be replaced. Family members have even added responsibility. Occurrence of a seizure in the individual changes his behaviour which in turn produces a change in behaviour and attitudes of the family members. It is increasingly recognised that improving the patients out look and behaviour may actually modify the epileptic experience and gives them courage and confidence to face the illness. Disorganised family makes it very difficult for the patient to pull on. Parents have to share the responsibility to ensure good compliance particularly in children. Patients with epilepsy do not require sympathy from the society but self respect. Patients with epilepsy have equal, if no more, rights in the society.

School and Teachers

Majority of the epileptic patients are normal children and adolescent boys and girls except that they have epilepsy. Many parents are scared to send their children to school because of the fear of injury. These children may have tongue bite, break their teeth, fractures and dislocation and contusions and abrasions and so on. Parents have to appreciate that such injuries can also occur at home inspite of every protective measures. It has now been well documented that over protection of the children with epilepsy is more harmful and is not required. Injuries can be reduced with the control of drugs and if injuries occur can be attended easily most of the time. These children already have one handicap, parents should not increase their children's handicap by preventing them to going to school. Some children with epilepsy have in addition mental retardation and other neurological deficits. Some of these children may not be able to cope with normal children in studies and extracurricular activities. Special schools should be provided to look-after the needs of these children. Children with epilepsy but slight below normal intelligence should be encouraged to attend normal school. These patients with epilepsy should be made to understand that to improve their handicap, they have to work harder in order to gain independence and self respect. Normal children in the school should be educated how to behave and deal with their school friends who have epilepsies. Teachers have an important role to play as well. Besides educating and providing the millieu for carrying on studies, they help in the diagnosis of new cases. Teachers need to be trained about the salient features of different forms of epilepsy, diagnosis and management. Children who show frequent lapses in concentration, memory and unresponsive period, or showing gradual scholistic deterioration should be suspected of having seizures and be referred to epilepsy clinics.

Marriage and children

Not very long ago in the first part of the 20th century, patients with epilepsies were not allowed to marry. Male patients with epilepsies were sterilized. These patients were treated in mental hospitals. These patients were prevented from social mixing and get together. Those concepts and those days are gone. Laws have been repealed which prevented them from marrying and having children. Majority of the people with epilepsy are in no way different than the people without epilepsy as far as the question of marriage and children is concerned. They have the full capability of sharing the family and social responsibilities. Some may have a few limitations but can manage with a little outside assistance. It is the understanding between two partners, respect for the other partner and understanding with the family members that makes the married life work successfully. If there is understanding, then epilepsy does not matter in the least. Some husbands who are epileptic take the advantage of epilepsy in inflicting injuries to their wives. Hypersexuality without any consideration of social norms and violent behaviour can be seen at times. Many in-laws and husbands grudge that they are being cheated by not disclosing the epilepsy which was present before marriage. All have to understand that epilepsy can occur to either after marriage. Epilepsy cannot be the ground for divorce as per Hindu Marriage Act, Section 13 (III), or for insanity as per Indian Contract Act, Section 12. If there is emotional or social conflict in a couple because of epilepsy, this is definitely going to affect the seizure control and which in turn will be reflected on occupation, social and financial aspects. Mutual cooperation should stabilise the married life and should have better impact on seizure control.

There should not be anything against having children because of epilepsy consideration. There is definite increased risk of epilepsy in the offsprings epilepsy or epilepsy traits but that should not deter anyone of having children. No one can predict at present which child among the offsprings is going to be affected. The first few children can be normal children and may not have epilepsy in life. Husband and wife both can be epileptic and yet have a few normal children who will never have epilepsy. One should realise that a child from normal parents without epilepsy, can have epilepsy. Therefore, to avoid misunderstanding, sufferings both social, emotional and economic and legal wrangles, I find no difficulty in suggesting that a marriage alliance between epileptic man and woman may be the answer.

Occupation

It is true that people with epilepsies should not be employed for some occupations. If, however, having worked in those occupations, they get seizures, should not be thrown out of the jobs. They should be rehabilitated in the same organisations in safer jobs. Conditions at work should be safe and healthy. Over congestion, humidity, high temperature, poor light and rough surroundings should be avoided and replaced by comfortable surroundings. Medical care should be made available without losing too much time. If a person is unfortunately hurt he or she should appropriately be compensated. Like any other worker, an epileptic person demands self respect and does not beg for sympathy. Persons with severe and uncontrolled seizures or with mental retardation or other neurological deficits should be enrolled as handicapped persons. To give them emotional happiness and self-respect, they should not mind working as handicapped people with less money but in safe surroundings and safe work. People have tendency to hide epilepsy or other disabilities. This leaves the way open for discrimination to take place when the epilepsy is discovered. During this process serious and fatal injuries may occur. All this is avoidable. People with epilepsy should not be discriminated because of epilepsy but differentiated by their abilities and capabilities for different jobs. Counselling should be provided at every stage and turn of life regarding their professional choice. The following jobs may not be suitable Navigation, driving, working with heavy machines and electrical goods, construction work, surgery and so on. However, one has to weigh all pros and cons before deciding a particular profession. All co-workers at the site of work should be educated about epilepsy, and all apprehensions and misconceptions should be done away with. Freedom for changing to a suitable and safer job in the same organisation should be freely available to these people with epilepsy.

Risk Factors

There are certain obvious risk factors which should clearly be explained to the patient and the family members. Counselling based on scientific facts and mutual trust when provided on the very first visit or at appropriate time, pays very high dividends. Many of these risk factors have to be evaluated from time to time during the course of therapy.

Driving : Driving should not be allowed at any cost when the seizures remain uncontrolled. Driving is not only injurious to oneself but injurious to many more on the road. It is immaterial whether seizures are major or minor or occurring during wakefulness or asleep. There is no guarantee that a person who gets the seizure during sleep may not get it during wakefulness. If the seizures gets under control the decision of permitting the patient for driving is difficult, controversial and dependent on many considerations. For some patients driving is not a matter of pleasure but necessity. Many patients have to deny that they have epilepsy and which makes it all the worse. Driving laws have to be taken under consideration. Different countries have different laws. For young children cycling is an important pastime as well as a necessity for mobility. Cycling may be allowed in the playground and other open spaces but not on the main busy road. Driving of the public transports should never be allowed.

Swimming : Swimming is a pleasure or sport for most people with epilepsy. It is not essential for life. Patients get drowned or hurt while diving. If swimming is essential, can be allowed provided a rescuer can keep an eye all the time on that person.

Cooking : Cooking is an important and integral daily ritual for most of the adult persons more so for women. There may only be a few women in our society who can be spared from cooking. Nothing is better than avoiding cooking. However, all patients who have to cook should be told about safe cooking. Cooking should be done standing and cooking ranges should have protective grill all around. Cooking with gas cylinders is safer than cooking on stoves or open wood or coal fire. Cooking should be reduced to the minimum possible time. Synthetic clothes and loose garments should be avoided while cooking. Fire alarms and fire protecting devices should be handy and easily approachable. With the slightest warning of the oncoming of a seizure person should move out to a safer place.

Climbing : Climbing on rocks or mountains is not an important hobby or sport in India. Climbing mountains is a group exercise. If one of the climbers happens to be epileptic and gets a seizure the life of others can be jeopardised. Climbing, however, on trees, ladders and roof tops is very frequent for varied purposes. This climbing is as dangerous as climbing mountains. Therefore, climbing should not be allowed.

Women and Pregnancy

Some forms of epilepsy are slightly more frequent in females. There may be a slight increase in the overall prevalence rate in females. The incidence of epilepsy in the offsprings of an epileptic mother is higher than the epileptic father. Some women have increased number of seizures during pregnancy while others may have less seizures. There is also an increased frequency of seizures in the premenstrual and menstrual phase in some females. Contraceptive pills are also associated with some increased risk of seizures, increased interactions with the antiepileptic drugs, and probably increased drug toxicity. Some antiepileptic drugs like diphenylhydantoin or sodium valproate, produce more unwanted side effects in women than in men. Emotional and other psychological upsets are more frequent following recurrence of seizures from whatever be the cause, in female patients, social prejudices are more frequently met by the female patients. Inspite of all these predilections, female patients have great capacity and tolerance to face the consequences of the epilepsy disorder. Society owes a great deal to its female members for their sacrifices and contributions to all members of the community. These few negative points should not create any untoward feelings rather instigate social services and scientists to do their best to improve their life style and well beings.

Alcohol and Nutrition

Seizures may occur at the time of alcohol withdrawl. Seizures may rarely occur as a complication of alcoholism. Alcohol may excerbate a pre-existing tendency to fits, or it may cause certain changes in the body metabolism which may provoke a fit. Alcohol anyway leads to great financial loss to the family, and many families may not be able to provide antiepileptic drugs if someone happens to have epilepsy.

Is there any special diet which can help the epileptic patient? This is very often asked in the clinic. A person who has got epilepsy is like any other normal person. He requires the same nutritious diet as anyone else. A person who takes good diet gets all necessary dietary constituents. Some antiepileptic drugs like diphenylhydantoin or phenobaritone may cause folic acid deficiency. Folic acid is adequately present in the normal diet. If there is deficiency for some reason, then some multivitamins may be taken but not on a regular basis.

State Governments

State Governments owe a great responsibility to these people who have epilepsy. They should understand the magnitude of the problem. There is a need for comprehensive epilepsy programme like it has started in many countries. Comprehensive epilepsy centres are charged with total care and rehabilitation of these patients. A wide spread network both in rural and urban areas should be given priority to provide necessary services. These services are : procuring and distributing all necessary drugs continuously all year around, counselling, education, psychological assistance. Our country also requires a few research centres for promoting research, formulating national policies, teaching and providing necessary manpower besides setting standard trends in the country.

Our leaders have pledged to take the country into the 21st century with modern technology at the doorstep of every one. This will be upset if we are not able to wipe out prejudices, false beliefs and misconceptions from our society and if we are not able to provide human rights, dignity and self respect to these boys and girls, and men and women. There is also a need for changes in legislation and industrial policy to protect and provide suitable employment. Attitudes of all employees are not alike and helpful. Similarly special schools should be started all over country to meet the needs of these children who have severe or poorly controlled epilepsy in addition to mental retardation and other neurological defiects.

FUTURE OUTLOOK

THE 20TH CENTURY HAS witnessed progress and developments in medical sciences in all spheres, Epilepsy is no exception. There has been phenomenal understanding in practically all aspects of epilepsy. Basic sciences have given many leads in understanding the causation of epilepsy. Continuous efforts are being made to understand some of the facts in the mechanism of epilepsy which are not clear today. Sincere efforts have gone into identifying genes, and more efforts are directed to use DNA recombinant technology for modifying epilepsy in future. Abundant information has accumulated about inhibitory neurotransmitters. This had led to the discovery of a few chemical compounds which are at present in various stages of drug trial. Attempts have been going on to improve the existing antiepileptic drugs and for the discovery of newer compounds with the sole aim to improve specific function and to reduce side effects. Such drugs in the armamentarium of the physician will go a long way to meet the requirements of the patients. Drug industries have to be very conscientious to make these newer drugs available to the poorest patients. We have seen many drugs like tridione, sulthiame etc disappear from the doctors armamentarium as they could not withstand the test of time. Newer drugs should ideally be cheap, effective and without side effects. Hopefully some of these drugs will be available in the near future. There have been tremendous achievements in the diagnostic fronts in the last two decades particularly in the morphological diagnosis. Metabolic and other functional changes in epileptic focus as studied by newer technology will pave the path for even better understanding. Surgical techniques have improved and hopefully more people will be benefitted. Concept of comprehensive epilepsy programmes will also pave the path for total rehabilitation, counselling, and psychosocial benefits. If one takes all seizure types then 10% may show spontaneous remissions without any treatment, 40-50% may show prolonged remissions after a 'seizure-free' interval following drug therapy, and remaining 40 to 50% need almost continuous medication. It is this latter group which should get further advantages from future developments. There is a bright future for most of the patients with epilepsy.

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Epilepsy is a major neurological problem all over the world. The prevalence rate of epilepsy in India is as high as one percent. Superstitions, false beliefs, and misconceptions about epilepsy still prevail widely both in rural and urban communities alike. The best way to prevent the persistance of these harmful social taboos and misbeliefs is to provide scientific information about the diagnoses, treatment and care of epileptics. This book attempts to do this. The future scope of advances in research for the treatment of epilepsy is discussed and an attempt is made to develop a scientific attitude in all those responsible for the treatment and care of epileptics.

The author, Dr. M. C. Maheshwari, is Professor and Head of the Department of Neurology at the All India Institute of Medical Sciences, New Delhi. He has a special interest in the treatment of epilepsy and has written more than fifty scientific papers, on different aspects of epilepsy both in national and international medical journals. He has been actively involved in several research activities on different aspects of epilepsy. However, his greatest inspiration and encouragement comes from alleviating the problems of his patients.

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